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Status of the Grizzly Bear (*Ursus arctos*) in Alberta

John L. Kansas

Alberta Wildlife Status Report No. 37

Alberta Conservation Association

Alberta
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PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991, 1996 and 2000, assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general statusing exercises (1996 *Status of Alberta Wildlife*, *The General Status of Alberta Wild Species* 2000), and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province ("At Risk," "May Be At Risk"), that are of uncertain status ("Undetermined"), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as "Endangered" or "Threatened" under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The grizzly bear (*Ursus arctos*) is considered "May be at Risk" in Alberta according to the *General Status of Alberta Wild Species 2000*. As of 1996, then Alberta Environmental Protection (AEP) considered the grizzly bear to be sustaining its population levels under a very restricted sport-hunting regime.

The first province-wide population estimate for Alberta grizzly bears was made in 1988. This estimate, made by Alberta government wildlife biologists was based on a conservative extrapolation of population density estimates from several relevant research projects. In 1988, there were an estimated 575 grizzly bears on Alberta provincial lands. Another 215 grizzly bears were estimated to occur in Waterton Lakes, Banff and Jasper National Parks, for a total provincial population of 790 animals. The 1990 *Alberta Grizzly Bear Management Plan* set a goal of increasing the 1988 population (including national parks) from 790 to 1000 bears.

Annual updates of the 1988 population estimates by the Alberta government indicate that the number of grizzly bears on Alberta provincial lands has increased from 575 to 841. Recent empirical population estimates in two areas of the province matched or significantly exceeded current population estimates as projected by the Fish and Wildlife Division. Presumed increases have resulted primarily from reduced legal hunting mortality associated with limited-entry hunting regulations imposed and maintained since 1988. Similar population projections are not available for the national parks. However, a recent conservative population estimate for national park populations is 175-185 bears in addition to the 841 on provincial lands.

Despite recent successes in population management and the reduction of grizzly bear mortality in Alberta, longer-term threats to this inherently sensitive species remain. The most serious threat to Alberta grizzly bear populations is human-caused mortality resulting from uncontrolled human access and activity. It is inevitable that human population densities and access into grizzly bear ranges will continue to increase in Alberta. The extent to which future human activities affect grizzly bear habitat and populations will depend on the degree to which management interventions are successful at limiting mortality risk and habitat displacement of grizzly bears. Management interventions with the greatest potential to mitigate effects on grizzly bears include the following: 1) continuation of limited-entry draw hunting restrictions; 2) access management in multiple use areas; and 3) intensive management to reduce problem bear conflicts in agricultural areas.

In addition to the need for management strategies, more research and population inventories are required to determine scientifically based approaches and limits to land use compatible with maintaining grizzly bear populations. Active cooperation between government, industry and the public will be required to support these studies and to understand their implications to shared land use activities.

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TABLE OF CONTENTS

PREFACE iii

EXECUTIVE SUMMARY iv

ACKNOWLEDGEMENTS v

INTRODUCTION 1

HABITAT 1

1. General 1
2. Foraging Habitat 1
3. Denning Habitat 3
4. Spatial/Home Range Habitat Requirements 3

CONSERVATION BIOLOGY 4

1. Demographic Compensation 4
2. Dispersal 5
3. Behavioural Plasticity in Food Acquisition 5

DISTRIBUTION 6

1. Alberta 6
2. Other Areas 7

POPULATION SIZE AND TRENDS 8

1. Alberta 8
2. Other Areas 16

LIMITING FACTORS 17

1. General 17
2. Human-Caused Mortality 17
   - Legal Harvest 18
   - Illegal Kill 18
   - Agency Control 19
   - Treaty Indian 19
   - Other 19
   - Unreported Mortality 19
3. Natural Mortality 19
   - Intraspecific Aggression 20

Malnutrition 20
Diseases and Parasites 20
4. Habitat Loss and Fragmentation 20
5. Fire, Fire Suppression and Timber Harvest 21
6. Habitat Carrying Capacity 22
7. Cumulative Effects and Landscape Condition Indicators 23
STATUS DESIGNATIONS 23
1. Alberta 23
2. Other Areas 24
RECENT MANAGEMENT AND RESEARCH IN ALBERTA 24
1. Eastern Slopes Grizzly Bear Project 25
2. The Rocky Mountain Grizzly Bear Planning Committee 25
3. The Yellowhead Ecosystem Carnivore Working Group 26
4. Southwestern Alberta Grizzly Strategy 26
5. A Strategic Framework for Grizzly Bear Conservation in the Yellowhead Ecosystem 27
6. Foothills Model Forest Grizzly Bear Research Program 27
7. Boreal Grizzly Bear Research Project 27
8. The Alberta C5 Forestry Project 27
SYNTHESIS 28
LITERATURE CITED 30
APPENDIX 1 Definitions of selected legal and protective designations. 42

LIST OF FIGURES

Figure 1 Grizzly Bear distribution in Alberta through the western portion of the province (as indicated by the bold line) (modified from Alberta Fish and Wildlife Division 1990). A colour version of Alberta's Natural Regions is available fromAlberta Community Development (http://www3.gov.ab.ca/env/parks/anhic/anhic.html). 2

Figure 2. Current and historical grizzly bear distribution in North America (adapted from B.C. Ministry of Envionment, Lands and Parks 1995). 9

Figure 3. The location of current grizzly bear management areas (BMAs) in Alberta's Natural Regions. A colour version of the Alberta Natural Region map is available from Alberta Community Development (http://www3.gov.ab.ca/env/parks/anhic/anhi..html). 11

Figure 4. Estimated grizzly bear population onAlberta Provincial Land (excluding national parks) from 1988-2000. 12

Figure 5. Trends in reported human-caused mortality of grizzly bears in Alberta 14

LIST OF TABLES

Table 1. Number of grizzly bears estimated to occur in Alberta Bear Management Areas (BMAs), 1988 - 2000 (excluding national parks). 12

Table 2. Total known mortality of grizzly bears by Alberta Bear Management Area (BMA), 1972 to 1999. 13

INTRODUCTION

According to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001) the grizzly bear (*Ursus arctos*) is considered "May Be At Risk"* in the province. Debate continues surrounding the grizzly bear's status, and studies to further assess population size, trends and the landscape conditions required for long-term grizzly bear persistence are planned or ongoing in several areas of the province. Researchers and managers in Alberta have spent considerable effort trying to understand the needs and status of the grizzly bear. Initial research in the 1970s and 1980s focused primarily on basic ecology and status. In the 1990s, grizzly bears' public profile increased because this species became a focal point for debate as an indicator of the effects of regional land use impacts and cumulative effects on natural ecosystems. This increasing profile has led to a second wave of research and management that attempts to determine grizzly bear population status and viability in the face of increasing multiple land use pressures.

This report summarizes historical and current information on the grizzly bear in Alberta, as a step in reviewing its status in the province.

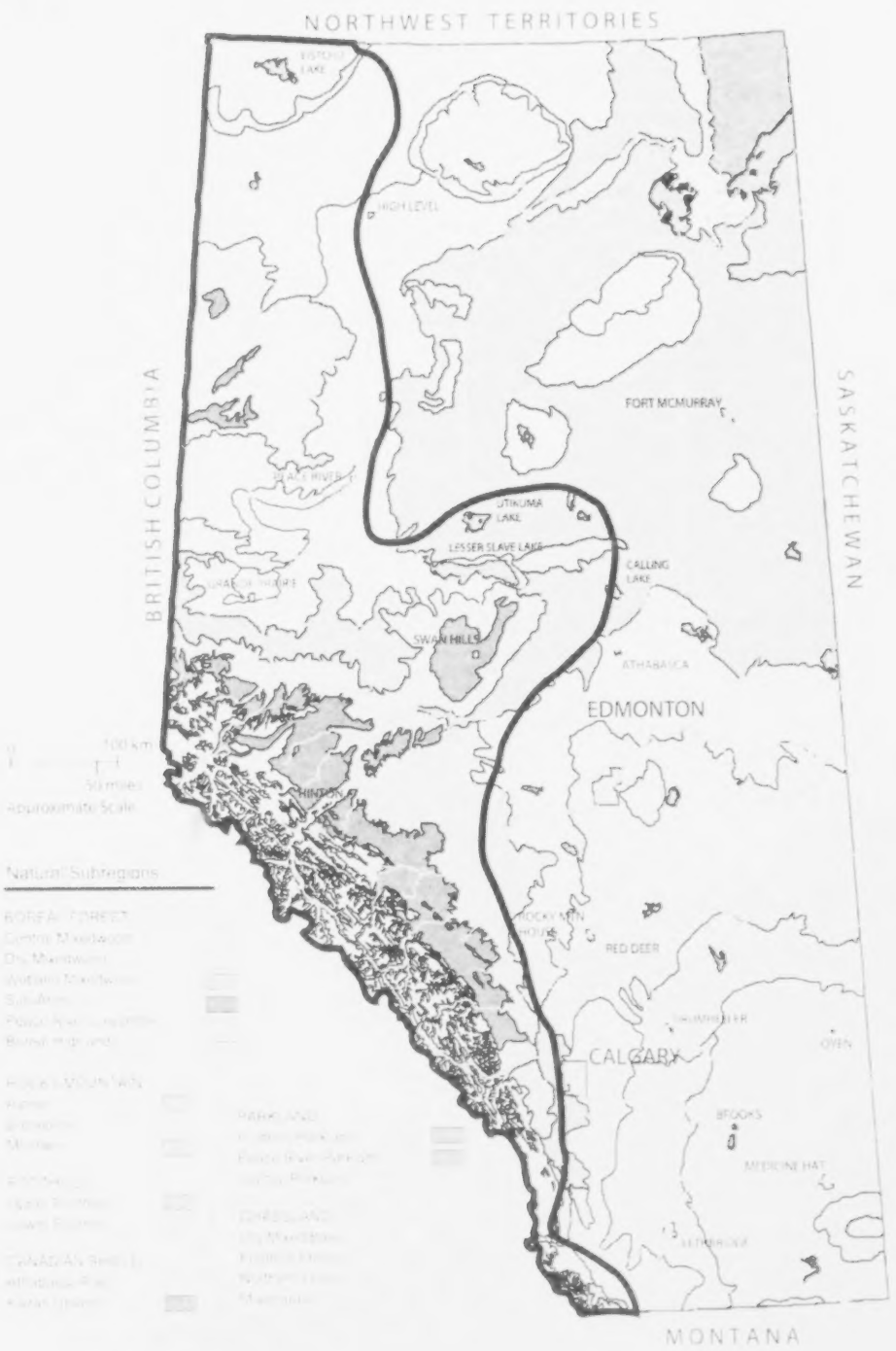
HABITAT

1. General. - Primary grizzly bear ranges include the Rocky Mountains and higher elevation portions of the Foothills Natural Regions and the Boreal Mixedwood region in west-central and northwestern Alberta. Secondary ranges occur contiguous with primary ranges, but are at lower elevations and are generally closer to high density human settlement. Grizzly bears occur in 13 of 20 Natural Sub-Regions as mapped by Alberta Environmental Protection (1994) (Figure 1). Grizzly bears do not occur in the Dry Mixedgrass, Northern Fescue and Mixedgrass Sub-Regions of southeastern Alberta. Other sub-regions in which grizzly bears are not resident include the Athabasca Plain and Kazan Uplands in the province's northeast corner, the Central Parkland, and the Peace River Lowlands. Grizzly bear ranges that support consistent resident grizzly bear populations are found primarily in the Upper and Lower Foothills, Subalpine, Montane, Alpine, Wetland Mixedwood, Sub-Arctic and Boreal Highlands (Alberta Fish and Wildlife Division 1990). Sub-regions that support grizzly bears seasonally or at very low population densities include the Central Mixedwood, Foothills Parkland, Peace River Parkland, and Foothills Fescue.

2. Foraging Habitat. - Grizzly bear use of habitat throughout their range largely corresponds with the location of seasonally favoured and high energy food sources (Stelmock 1981, Craighead and Mitchell 1982, Hamer and Herrero 1983). This tendency for grizzly bears to occupy areas with concentrations of high quality foods can be modified in areas with high levels of human use, especially when security cover is lacking. Food occurrence and abundance varies by natural region although there is considerable overlap in the occurrence of preferred foods between regions. Five main food groups compose most of the diet in all regions: (1) graminoids-grasses; sedges and rushes; (2) forbs/forb roots; (3) berries and pine seeds; (4) mammals, including ungulates and rodents; and (5) insects, including ants and wasps.

Mountain and foothills habitats that support graminoids used by grizzly bears in early spring are dry, steep south- and west-facing subalpine grasslands overlying colluvial, residual and morainal landforms (Hamer and Herrero 1983, Kansas and Riddell 1995). Poorly drained hairgrass (*Deschampsia cespitosa*)-sedge (*Carex* spp.) meadows are used by grizzly bears in early summer and are found in moderate to high

* See Appendix 1 for definitions of selected status designations.



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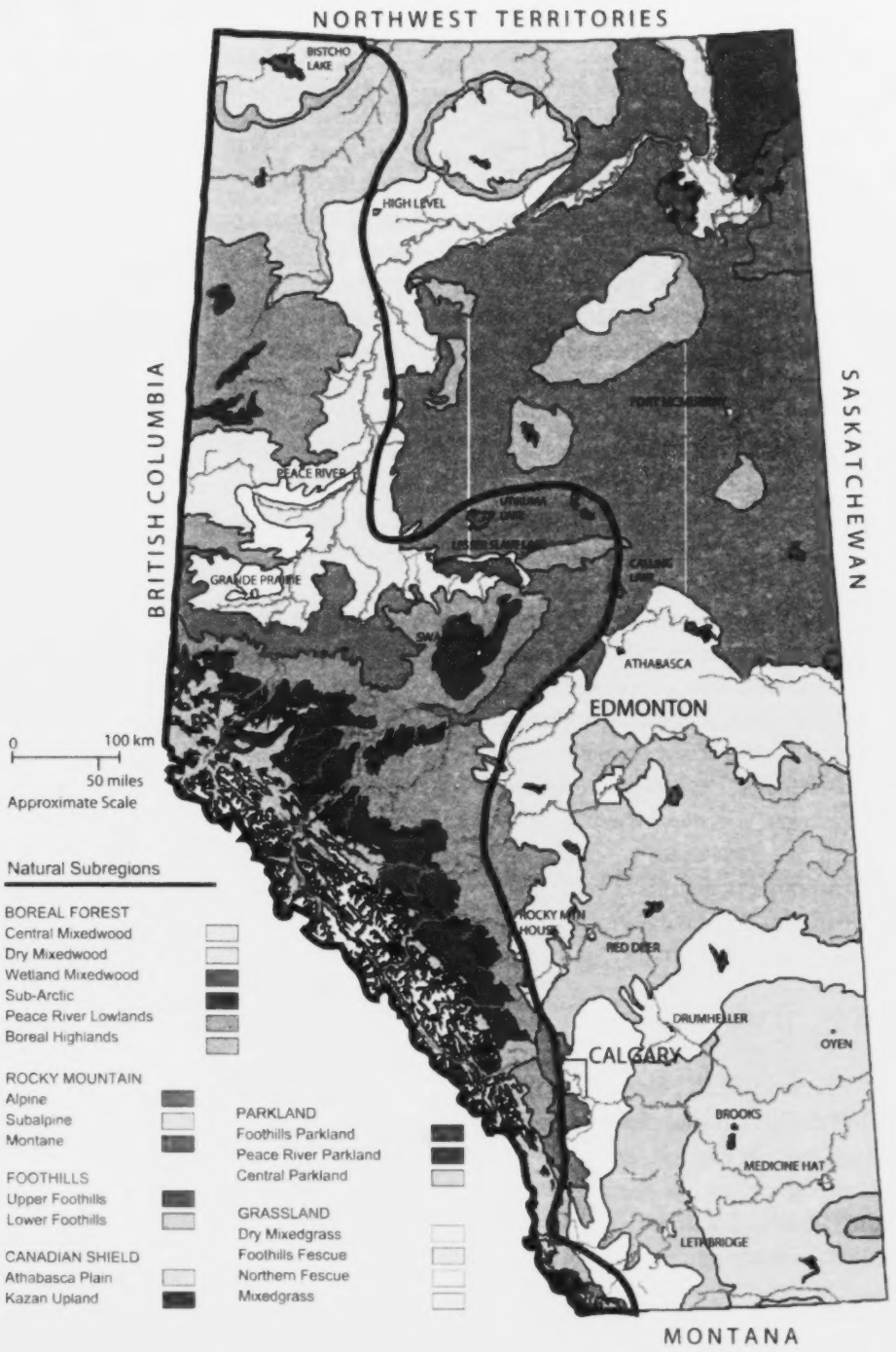

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elevation valley bottoms and bottoms of tributary streams (Hamer and Herrero 1983). Use of graminoids in boreal regions tends to occur primarily during the early summer period (Nagy and Russell 1978) and likely occurs primarily in sedge/hairgrass wetlands. Habitats most likely to support root feeding activity in the Rocky Mountains and foothills are dry and mesic willow (*Salix* spp.)-dwarf birch (*Betula glandulosa*) shrub meadows (Hamer and Herrero 1983), well-drained south- to west-facing grasslands with loam-textured soils (Holcroft and Herrero 1984, Hamer 1996a), streamside point-bars (Kansas and Newyar 1998) and moist meadows and open forests near treeline (Raine and Riddell 1991). Roots and bulbs are less abundant in boreal mixedwood and foothills environments and this is reflected in the literature, as there is a lesser reported use of these food sources in boreal grizzly bear studies (Nagy and Russell 1978, Nagy et al. 1989). In the boreal forest, most root-foraging habitat occurs along stream banks and channels.

Wet streamsides in mature spruce forest, gully bottoms, groundwater seepage areas, wet meadows and fens, and disturbed sites (e.g., roadsides) are habitats used by grizzly bears in late spring and early summer. During the mid-summer period, toes of avalanche slopes, moist east- and north-facing slopes near treeline, moist gully bottoms, regenerating burns and clearcuts, and groundwater seepage areas are favoured by grizzly bears. These habitats support productive herbaceous forage sources such as cow parsnip (*Heracleum lanatum)*. Pipeline rights-of-way, roadside verges and other man-made clearings are also used extensively by grizzly bears during spring and early summer (Nagy and Russell 1978, Mace and Bissell 1985).

By late July and early August, grizzly bears switch to berry feeding. In drier Rocky Mountain front range and foothills areas the principal berry producing plant is Canadian buffaloberry (*Shepherdia canadensis)* (Hamer and Herrero 1983, Hamer 1996a, Kansas and Newyar 1998). This species is found on a variety of sites but tends to be most productive on coarse-textured soils and under open canopies, well-drained and early succession forests and low shrublands (Hamer 1996b). In areas closer to the Continental Divide, grizzly bears feed mostly on *Vaccinium* spp. Habitats that support these foods are variable but most are concentrated in semi-open, upland mesic forests and burned areas (Hamer et al. 1990, Raine and Riddell 1991). Berry-producing habitats are more widespread in the boreal forest than in the Rocky Mountains and foothills.

Food habit models completed in the mountains and foothills of the Central Rockies Ecosystem have consistently shown that lower elevation valley bottom habitats, especially those found in the Montane Natural Sub-Region, support the highest diversity and productivity of foods for grizzly bears (Kansas and Riddell 1995, Eastern Slopes Grizzly Bear Project 1998).

3. Denning Habitat. - Grizzly bears in the Rocky Mountains prefer to den in habitats that support deep snow conditions. Typical site characteristics from Alberta studies report mean elevations of 2085 m to 2280 m, steep slopes ranging from 30% to 80%, and dominantly north- and east-facing aspects (Russell et al. 1979, Vroom et al. 1980, Raine and Riddell 1991). Den habitat preferences in the boreal forest are less understood.

4. Spatial/Home Range Habitat Requirements. - Because of a combination of social and other ecological requirements, grizzly bears require large areas of land or "space" on an annual and lifetime basis. Annual home ranges of individual adult grizzly bears in the Canadian Rocky Mountains range from 165 km^2 to 532 km^2 for females and 644 km^2 to 1628 km^2 for males (Russell et al. 1979, Hamer and Herrero 1983, Raine and Riddell 1991, Gibeau and Herrero 1999). Alberta Fish and Wildlife Division (1990)

reported home ranges of 252 km^2 to 502 km^2 for females and 1918 km^2 to 2755 km^2 for males in the boreal forest of west-central Alberta.

Grizzly bears also require a mix of seasonal habitats in their annual home ranges in order to have sufficient access to the full range of primary food sources. A bear that has forb-rich avalanche slopes, riparian areas with horsetail and productive berry crops in its home range will have a greater chance to prosper energetically than one in a landscape that is homogeneous with respect to vegetation and topography. This concept of "seasonal equity" of food sources (Weaver et al. 1986) is vital to long-term grizzly bear persistence on the landscape. It is also important as it demonstrates the influence of spatial requirements of grizzly bears within different ecological regions (e.g., mountains versus boreal forest).

CONSERVATION BIOLOGY

There is clear historical evidence in Alberta and elsewhere in North America of reductions in the size and distribution of grizzly bear populations that resulted from a widespread loss of habitat and excessive killing (Noble 1972, Nielsen 1975, Nagy and Russell 1978, McCrory and Herrero 1982, Alberta Fish and Wildlife Division 1990). There are a number of aspects of grizzly bear biology that have made this species particularly susceptible to such local and regional population reductions. Weaver et al. (1996) reviewed aspects of large carnivore biology that had the greatests influence on grizzly bear populations. They applied the concept of resilience as defined by Holling (1973) to be "the ability of systems to absorb disturbance and still maintain the same relationship between populations or state variable."

Behaviours or life history traits of grizzly bears that were considered to have the greatest influence on resilience were demographic compensation, dispersal, and behavioural plasticity in food acquisition. Demographic compensation refers to the capacity of individuals to respond to increased rates of juvenile and adult mortality with increased reproduction and/or survival (Weaver et al. 1996). Inherent demographic performance allows a species to counter overexploitation of populations. Dispersal refers to movements of juvenile animals when leaving their natal range after reaching the age of independence (Weaver et al. 1996). Successful dispersal establishes functional connectivity between metapopulations and lessens the risk of regional extirpation from habitat fragmentation (Weaver et al. 1996). According to Weaver et al. (1996), behavioural plasticity in food acquisition is the capacity of individuals to substitute one food resource for another in the face of environmental disturbance. Behavioural plasticity in food acquisition can serve to counter changes or reductions in food availability resulting from habitat loss.

1. Demographic Compensation. - Grizzly bears have a low reproductive potential relative to other large carnivores (Weaver et al. 1996). This results from a combination of a later onset of reproduction, small litters and longer periods between litters. Age of first reproduction is from four to eight years (Herrero 1978, LeFranc et al. 1987, Mace and Waller 1997, Garshelis et al. 2001). In comparison, age at first reproduction is two to four years for cougars (Jalkotzy et al. 1992), two to seven years for black bears (Alberta Fish and Wildlife Division 1993), and two years for wolves (Alberta Fish and Wildlife Division 1991). Maximum ages of successful reproduction reported for grizzly bears range from 18.5 to 24.5 years (Craighead et al. 1969, Pearson 1975, Nagy and Russell 1978, Nagy et al. 1983a, Mace et al. 1996, Gibeau and Herrero 1997).

Alberta grizzly bear studies have reported average grizzly bear litter sizes of from 1.6 to 2.2 (Nagy and Russell 1978, Russell et al. 1979, Nagy et al. 1989). Gibeau and Herrero (1997) documented 27 grizzly bear family units in the Bow River watershed of Alberta between 1993 and 1996 and reported an average litter size of 1.93. Mean

litter size of a recent major grizzly bear study in Montana was 1.64 (Mace and Waller 1997). In contrast, average litter sizes of black bears, wolves and cougars are 2.2 to 2.4 (Gunson and Cole 1977, Nagy and Russell 1978, Nagy et al. 1989), 5.0 (Alberta Fish and Wildlife Division 1991), and 2.2 (Jalkotzy et al. 1992), respectively.

Female grizzly bears produce young every two to five years in North America (Craighead and Mitchell 1982). The reproductive interval for Alberta grizzly bear studies was observed to be three years in the Swan Hills (Nagy and Russell 1978) and approximately four years in west-central Alberta (Nagy et al. 1989). A recent six-year study of grizzly bears in the Bow Valley watershed in Alberta calculated a mean reproductive interval of five years (Garshelis et al. 2001). Reproductive intervals for black bears, wolves and cougars are considerably shorter at two, one, and one to two years, respectively (Alberta Fish and Wildlife Division 1991, Jalkotzy et al. 1992, Alberta Fish and Wildlife Division 1993).

Wielgus and Bunnel (1994) reported an estimated reproductive rate per female of 0.23 female cubs/year in Kananaskis Country. Subsequent work from 1994 to 2000 in the Bow Valley watershed of Alberta (including Kananskis Country) reported a reproductive rate of 0.19 female cubs/year (Garshelis et al. 2001). For the Swan Mountains of Montana, Mace and Waller (1996) reported a reproductive rate of 0.26 cubs/year.

2. Dispersal. - Grizzly bears have low dispersal capabilities relative to other large carnivores (Weaver et al. 1996). This is especially true for subadult female grizzly bears, which usually establish their home range within or adjacent to the maternal range (Pearson 1975, Nagy et al. 1983a, Blanchard and Knight 1991). This inherent fidelity of female grizzly bears to their maternal home ranges reduces the speed with which this species can recolonize areas where breeding populations have been depleted (Barrett et al. 1983 in Alberta Fish and Wildlife Division 1990, Weaver et al. 1996).

3. Behavioural Plasticity in Food Acquisition. - Grizzly bears ingest a wide variety of plant and animal foods (LeFranc et al. 1987). Use of specific food items varies by season, according to dietary needs and the availability and nutritional status of foods (Mealey 1975, Sizemore 1980, Hamer and Herrero 1983). Grasses and sedges are grazed primarily in the spring and early summer (May and June) in the mountains and foothills (Russell et al. 1979, Hamer and Herrero 1983, Hamer et al. 1985, Kansas and Newyar 1998).

The roots of several forb species are important sources of carbohydrate and crude protein for grizzly bears during all seasons. All of the grizzly bear studies in Front Ranges of the Rocky Mountains in Alberta have documented significant use of both pink and yellow hedysarum (*Hedysarum alpinum*, and *H. sulphurescens*) roots (Russell et al. 1979, Hamer and Herrero 1983, Hamer et al. 1985, Wielgus 1986, Kansas and Newyar 1998). Digging for hedysarum in the mountains and foothills occurs most extensively during spring and fall. Studies conducted in areas of the Main Ranges of the Rocky Mountains have noted an increased use of glacier lily corms with reduced use of hedysarum (McCrory et al. 1982, Raine and Riddell 1991, Kansas and Newyar 1998).

The stems, leaves and flowers of several species of succulent forbs are eaten by grizzly bears during the green vegetation season (early June to late July). Some disproportionately favoured forb species in Alberta are common horsetail (*Equisetum arvense*), cow parsnip (*Heracleum lanatum*), mountain sorrel (*Oxyria digna*), and angelica (*Angelica* spp.). Other native forbs regularly eaten by grizzly bears include peavine (*Lathyrus ochroleucus*), American vetch (*Vicia americana*), arrow-leaved groundsel (*Senecio triangularis*) and sweet cicely (*Osmorhiza* spp.).

Introduced forbs such as sweet clover (*Melilotus alba*), dandelion (*Taraxacum officianale*) and wild vetch (*Astragalus* spp.) are also attractive food sources for grizzly bears.

Throughout North America, fruits and conifer seeds are the preferred high-energy foods for grizzly bears during the late summer and the autumn pre-denning fattening period (Blanchard and Knight 1991, Mattson et al. 1992, Hamer 1996a). The primary fall foods for grizzly bears in Alberta are berries. The roots of *Hedysarum* (spp.) are also important to grizzly bears in mountain and foothills environments during the fall (Hamer and Herrero 1983), especially in years of berry crop failure. In the Front Ranges of the central Rocky Mountains, the most commonly eaten berry is the buffaloberry (*Shepherdia canadensis*). Other important berry-producing shrubs in Front Ranges are common bearberry (*Arctostaphylos uva-ursi*), crowberry (*Empetrum nigrum*), low bilberry (*Vaccinium caespitosum*), and gooseberry (*Ribes* spp.) (Kansas and Riddell 1995). The most commonly eaten berries in the Main Ranges of the Rockies are blueberry (*Vaccinium myrtillus*) and tall bilberry (*Vaccinium membranaceum*). Important berry-producing shrubs in the boreal forest are blueberry, low-bush cranberry (*Viburnum edule*), and bracted honeysuckle (*Lonicera involucrata*).

Animal protein, primarily in the form of winter-killed or rut-weakened ungulates and newborn calves (Hamer and Herrero 1991) is increasingly being found to be crucial to a grizzly bear's diet (Hewitt 1989, Pritchard and Robbins 1990, Herrero and Herrero 1996). All Alberta Rocky Mountain and foothills grizzly bear studies have shown that ungulates are eaten consistently by grizzly bears, primarily during the spring (Hamer and Herrero 1983, Hamer et al. 1985, Wielgus 1986, Raine and Riddell 1991, Kansas and Newyar 1998). Use of ungulates by grizzly bears appears to be less common in the boreal forest (Nagy and Russell 1978, Nagy et al. 1989). Ground squirrels are a large component of the grizzly bear's diet in moist subalpine forb and shrub meadows and grasslands in the Main Ranges of the Rocky Mountains (Raine and Riddell 1991, Kansas and Newyar 1998). Ground squirrels are less commonly preyed upon in the boreal forest (Nagy and Russell 1978, Nagy et al. 1989) and dry Front Ranges of the Rocky Mountains (Hamer and Herrero 1983).

Insects are a minor, yet consistent, food source for grizzly bears. Ants and ant larvae are the most common insect food and are eaten mainly in the mid-summer period (Hamer and Herrero 1983, Raine and Riddell 1991) after grasses and succulent forbs such as horsetail are cured and before fruit production occurs.

The wide variety of food items eaten by grizzly bears makes them relatively adaptable or plastic in terms of their acquisition of food resources (Weaver et al. 1996). The possible exception to this is during the fall period when grizzly bears rely on berries to acquire the majority of their fat reserves for the winter hibernation period (Herrero 1985, Hamer 1996a). At this time, grizzly bears rely on specific habitat types that produce concentrated berry crops and tend to remain for longer periods in these areas.

DISTRIBUTION

1. Alberta. - Historical records confirm that the grizzly bear was once abundant in several areas of the province of Alberta where it is now extirpated or transient. Some of these areas include the Cypress Hills and the prairie/agricultural reaches of major river valleys such as the Peace, Bow, and North and South Saskatchewan (Alberta Fish and Wildlife Division 1990). The grizzly bear was abundant across the Alberta prairies in the 1700s and 1800s (Spry 1968, Nielsen 1975). However, with increasing numbers of explorers and fur-traders, and improved firearms, grizzly bear numbers began to decline.

Farming, ranching and the establishment of settlements in the 1870s led to a major range reduction, and the final extirpation of the prairie-dwelling grizzly bears (Nielsen 1975). McCrory and Herrero (1982) reported that grizzly bears were extirpated by ranchers from the grassland areas of the Bow and Highwood rivers by the 1890s. Additional "rancher control" abetted by rabies control programs greatly reduced grizzly bear occurrences in the Front Ranges of Kananaskis Country in the 1940s and 1950s. By the late 1950s and early 1960s, the need for increased protection of grizzly bear populations was recognized and implemented through hunting restrictions.

The most recent grizzly bear management plan (Alberta Fish and Wildlife Division 1990) offers the latest data regarding the distribution of grizzly bears in Alberta. This report mapped known locations of grizzly bear kills from 1972 to 1987 and personal/property damage complaints from 1980 to 1986. Based on these data, grizzly bears were known to occur in 74 of the 157 Wildlife Management Units (WMUs) in Alberta. The total proportion of provincial lands (excluding national parks) that grizzly bears occupy is approximately 34% (200 000 km^2/584 784 km^2) (Gunson 1997, H. Carr, pers. comm.). Including Banff, Jasper and Waterton Lakes National Parks, grizzly bears occupy 35% (276 404 km^2/661 188 km^2) of the entire province . The grizzly bear management plan (Alberta Fish and Wildlife 1990) estimated that bears occupied 154 034 km^2 of provincial lands. This is a very conservative estimate that was based on grizzly bear occupation of only undisturbed and/or undeveloped provincial lands (Alberta Fish and Wildlife Division 1990, H. Carr, pers. comm.). The area of occupation has likely increased considerably since the grizzly bear management plan was published, because grizzly bears are now found east of Peace River, Lesser Slave Lake and the Swan Hills, and further east along the foothills from Drayton Valley to Pincher Creek (H. Carr, pers. comm.).

Grizzly bear ranges in Alberta are classified as either "primary" or "secondary." Primary ranges are defined as those where "substantial numbers of resident grizzly bears can be maintained through intensive management and conservation programs" (Alberta Fish and Wildlife Division 1990). Secondary ranges are defined as "seasonally important to some grizzly bear populations but existing land use activities preclude these areas from supporting substantial resident grizzly bears" (Alberta Fish and Wildlife Division 1990). As of 1990, primary ranges occupied 78% of total grizzly bear range and secondary ranges comprised 22%.

Figure 1 shows the distribution of grizzly bears in the western half of Alberta. They occur in 13 of 20 Natural Sub-Regions as mapped by Alberta Environmental Protection (1994).

2. Other Areas. - The grizzly bear is a subspecies of the brown bear (*Ursus arctos*). The brown bear range is the most widespread of any bear species comprising portions of Europe, Asia and North America (Servheen 1990). Worldwide, brown bears historically ranged through Asia, the Middle East, North Africa, Europe, Great Britain and North America (Servheen 1990). Today, their global range has been reduced by half (B.C. Ministry of Environment, Lands and Parks 1995). With the exception of the northern portion of Eurasia, brown bear populations outside of North America have experienced similar levels of habitat fragmentation to that of the contiguous United States. Some populations in Great Britain and North Africa were extirpated more than a century ago (Servheen 1990).

There are two subspecies of brown bear in North America - the continental grizzly bear (*U. a. horribilis*), and the brown bear of the Alaskan islands (*U. a. middendorffi*). In North America, the grizzly once roamed from the Pacific Ocean to the Mississippi River, and from Central Mexico to the Arctic Ocean (B.C. Ministry of

Environment, Lands and Parks 1995). Extensive land clearing for agricultural purposes and high-density human settlement caused the extirpation or significant reduction of grizzly bear populations over large portions of their historic range (Cowan 1972, Nielsen 1975, McCrory and Herrero 1982, Servheen 1990). The southern extent of the distribution of grizzly bears in North America is now restricted to relatively unsettled areas in the northwestern United States. In the contiguous United States, the grizzly bear has been eliminated from 99% of its historic range and now remains in six separate populations, four of which are contiguous with grizzly bear populations in Canada. Once distributed across western and central Canada, the grizzly is now restricted to relatively uninhabited portions of British Columbia, the boreal forest of Alberta, Yukon and Northwest Territories, and a band of mountains and foothills between the plains and the Continental Divide of the Canadian Rockies (Figure 2).

The vast majority of the reductions in historic range reported above for grizzly bears in North America occurred during a pioneer era of unrestricted market hunting and rapid conversion of natural lands to agricultural fields. Reductions in grizzly bear range have slowed considerably in the last 50 years relative to the major impacts associated with this era.

POPULATION SIZE AND TRENDS

1. Alberta. - Assessing the population status and trend of grizzly bears is difficult when compared to most other vertebrate wildlife species. Inherently low population densities, winter inactivity and poor sightability make censusing scientifically challenging and expensive. It is estimated that there were approximately 6000 grizzly bears in Alberta in the 1800s (Herrero 1992). This estimate was based on an assumed density of at least one bear/100 km^2 across the 600 000 km^2 that constitutes Alberta (S. Herrero, pers. comm.). The accuracy of this historical estimate remains unsubstantiated.

The total estimated grizzly bear population in 2000 (excluding national parks) was 841. The Alberta Fish and Wildlife Grizzly Bear Management Plan (1990) estimated the total population of grizzly bears in Jasper, Banff and Waterton National Parks at 215 bears. National park representatives were asked to provide an up-to-date grizzly bear estimate for each park. There are an estimated 100-110 grizzly bears (all age classes) in Jasper National Park, which is based on data from their study in the late 1970s and the ongoing Foothills Model Forest grizzly bear study (W. Bradford, pers. comm.). The number of grizzly bears in Banff National Park is currently unknown, but a conservative estimate of 60 bears (males and females) is used for planning purposes (T. Hurd, pers. comm.). The most recent estimate from Waterton Lakes National Park is from a 1998 study of Waterton and surrounding area, which suggests approximately 15 bears in the park (Mowat and Russell 1998). Therefore, the current grizzly bear population estimate for Alberta national parks is 175 to 185 bears. It should be noted that this number is very conservative and does not necessarily mean there has been a decrease in the number of grizzly bears in national parks.

The status of grizzly bear populations has fluctuated in this century with changes in the classification of the grizzly from its perceived image as a predator, to its official designation as "fur-bearer" in 1928. It was afforded further protection as a "big game animal" in 1929 (Alberta Fish and Wildlife Division 1990). Despite this, by the late 1940s, ranchers along the east front of the Rocky Mountains had reduced the grizzly population significantly in the foothills and mountain valleys (McCrory and Herrero 1982). Protection was still minimal in the 1950s and inadequate regulation of killing grizzlies by landowners, cattlemen and hunters, resulted in a further decline in grizzly bear numbers (Alberta Fish and Wildlife Division 1990). More protection was afforded in the 1960s, with more stringent hunting restrictions and surveys of hunter harvests. The Alberta population likely increased

Figure 2. Current and historical grizzly bear distribution in North America (adapted from B.C. Ministry of Environment, Lands and Parks 1995).

in the 1970s, but concerns of unsustainable mortality in the 1980s led the Alberta Fish and Wildlife Division to enact several management policies with the goal of increasing the provincial population outside of national parks to 1000 grizzlies (Alberta Fish and Wildlife Division 1990).

Systematic records of grizzly bear occurrences, mortalities and translocations have been kept in Alberta since 1971. A detailed provincial grizzly bear management plan was published in 1990 and included the first estimates of populations for 21 Bear Management Areas (BMAs). These estimates were based on conservative extrapolations of baseline population densities from field research studies available as of approximately 1989 (Nagy and Russell 1978, Russell et al. 1979, Carr 1989, Nagy et al. 1989). Population densities of grizzly bears from field research projects were extrapolated to BMAs with similar ecological conditions and were then discounted based on objective measures of land surface disturbance (Pedocan Land Evaluation Ltd. 1984). The measured disturbance value was multiplied by two (= total disturbance value) to take into account the large home ranges and mobility of grizzly bears and the projection of disturbance effects beyond the physically disturbed areas (Alberta Fish and Wildlife Division 1990). Total surface disturbance values used for BMAs averaged 45%. The locations of current Alberta BMAs are shown in Figure 3.

In the case of BMAs 4A, 4B and 4C, in the mountains and foothills east and north of Banff and Jasper National Parks, the baseline population density estimate (Russell et al. 1979) was halved from 10 bears/1000 km^2 to 5 bears/1000 km^2 (Alberta Fish and Wildlife Division 1990). This was done to reflect the effects of past grizzly bear harvest.

Since 1988, Alberta Sustainable Resource Development has been making annual updates to the original grizzly bear population estimates within Bear Management Areas in the province. These estimates modify the previous year's population estimate based on net translocations, estimated net immigration and net natural growth (Gunson 1996). Net natural growth is defined as allowable human-caused mortality at 6% per year minus known mortality (plus 25% unknown mortality). Six percent to 6.5% is considered to be the scientifically acceptable human-caused mortality rate above which mortality could cause a population decline (Harris 1986, Eastern Slopes Grizzly Bear Project 1998, McLellan et al. 1999).

Table 1 provides Alberta Sustainable Resource Development's grizzly bear population estimates for BMAs and groups of BMAs on Alberta provincial lands from 1988 to 2000. Figure 4 illustrates trends in the total estimated grizzly bear population for Alberta provincial lands (excluding national parks) from 1988 to present. The population estimates provided in Table 1 and Figure 4 are affected mainly by known human-caused mortality. Table 2 provides annual records of the number of reported human-caused grizzly bear mortalities per Bear Management Area since 1972. Figure 5 illustrates trends in total reported human-caused mortality per year on Alberta provincial lands from 1972 to present.

Based on the above Alberta Fish and Wildlife Division estimates, the total Alberta grizzly bear population has increased from 575 animals in 1988 to an estimated 841 in 2000 (excluding national parks). BMAs with large increases are REM (105%), 3B (+81%), 4A (+67%), 1 (+63%), 3A (+52%), 2B (+47%) and 4B (29%). With the exception of BMA 1, the largest estimated increases have occurred in northern Rocky Mountains and foothills regions. BMA 1 is found primarily in boreal mixedwood, northland and sub-arctic habitat in northwestern Alberta. The remainder areas (REM) supported the highest estimated increase in population (+105%). REM includes BMA 5 (Kananaskis Country), Peter Lougheed Park, WMU 410 (Bow Corridor),

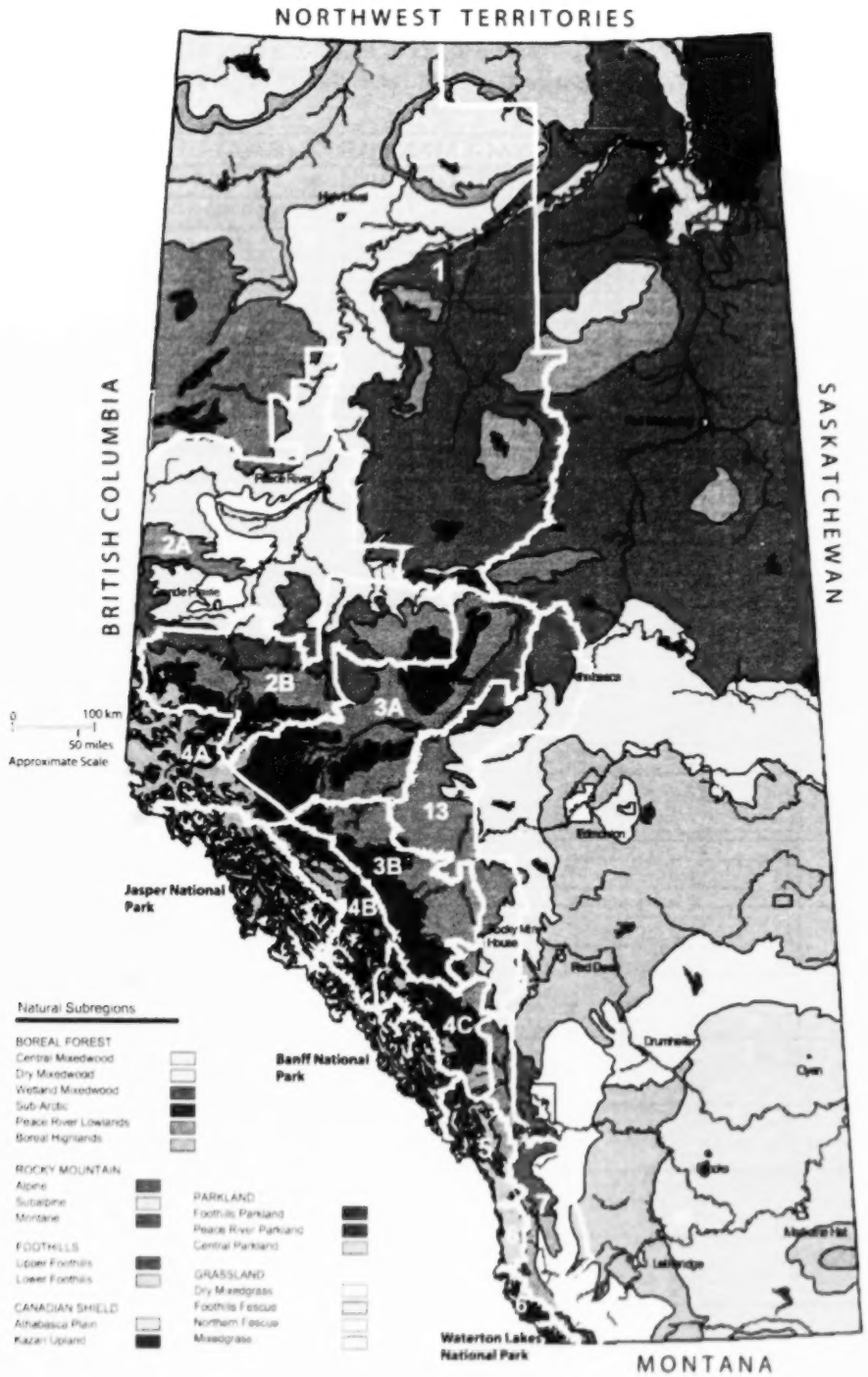

Figure 3. The location of current grizzly bear management areas (BMAs) in Alberta's Natural Regions. A colour version of Alberta's Natural Region map is available from Alberta Community Development (http://www3.gov.ab.ca/env/parks/anhic/anhic.html).

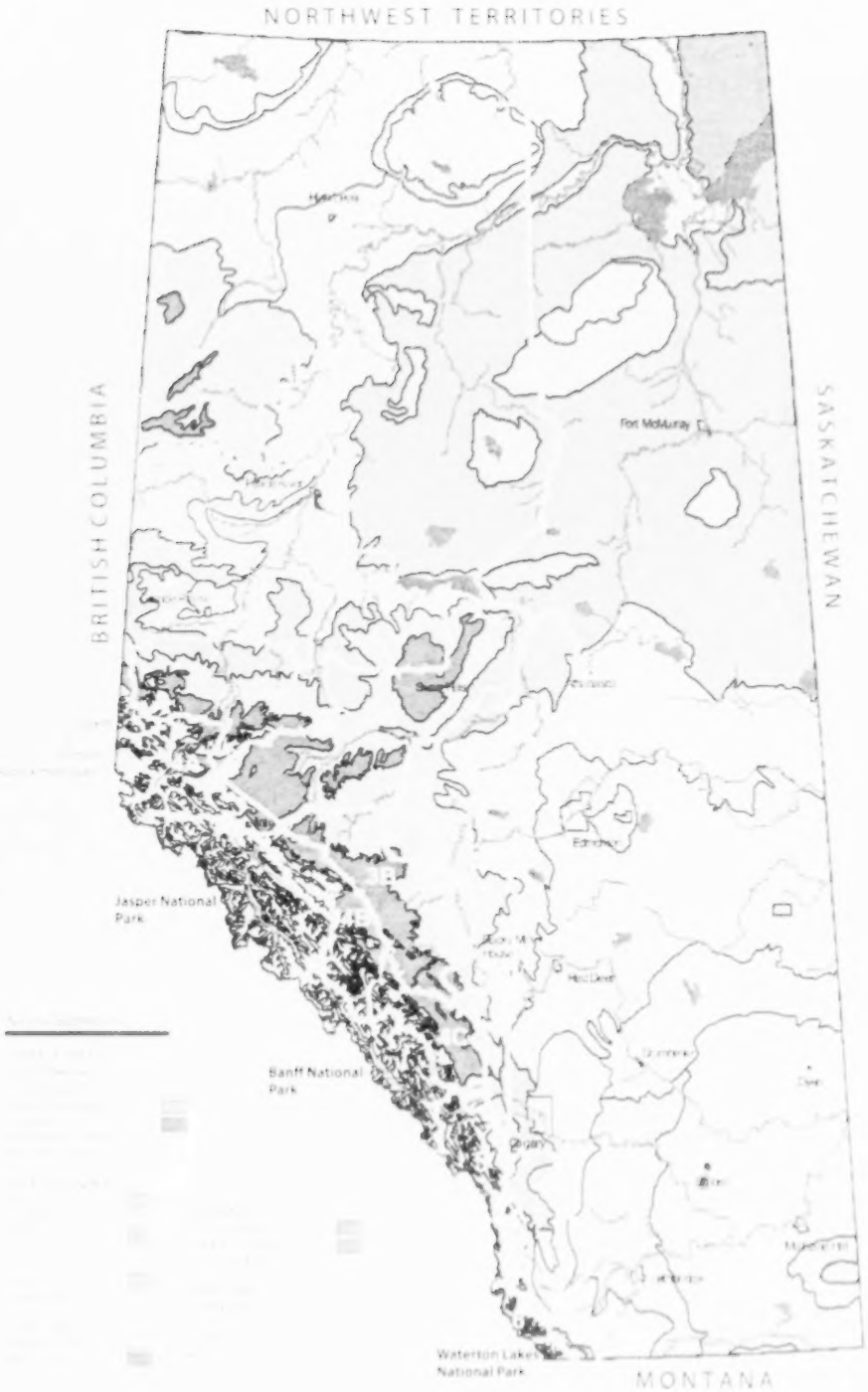

Figure 3. The location of current grizzly bear management areas (BMAs) in Alberta's Natural Regions. A colour version of Alberta's Natural Region map is available from Alberta Community Development (http://www3.gov.ab.ca/env/parks/anhic/anhic.html).

Table 1. Number of grizzly bears estimated to occur in Alberta Bear Management Areas (BMAs), 1988 - 2000 (excluding national parks).

YEAR	BEAR MANAGEMENT AREA (BMA)										
	1	2A	2B	3A	3B	4A	4B	4C	6&7	REM**	TOTAL
1988	82	22	127	79	26	52	34	35	45	73	575
1989	84	18	126	85	27	46	30	22	27	71	536
1990	90	16	128	88	28	46	35	22	24	70	547
1991	90	21	136	86	29	65	43	33	47	88	638
1992	92	21	143	88	31	72	46	33	47	96	669
1993	93	21	145	97	30	82	45	28	43	102	686
1994	96	22	150	101	33	75	45	28	42	108	700
1995	102	23	158	108	33	77	44	31	46	113	735
1996	109	21	168	112	34	80	46	33	44	118	765
1997	119	17	171	108	35	78	47	35	40	126	776
1998	124	13	176	120	37	79	50	36	31 (57)*	141	807 (833)
1999	126	10	183	124	44	83	48	37	31 (55)	147	833 (857)
2000	134	7	187	120	47	87	44	35	30 (54)	150	841

* Numbers in brackets represent revised population estimates taking into account DNA-based population density findings (Mowat and Russel 1998).

** REM = Remainder of Province including BMA 5 (Kananaskis Country), Lougheed Provincial Park, WMU 410 (Bow Corridor), BMA 13 and BMA 16.

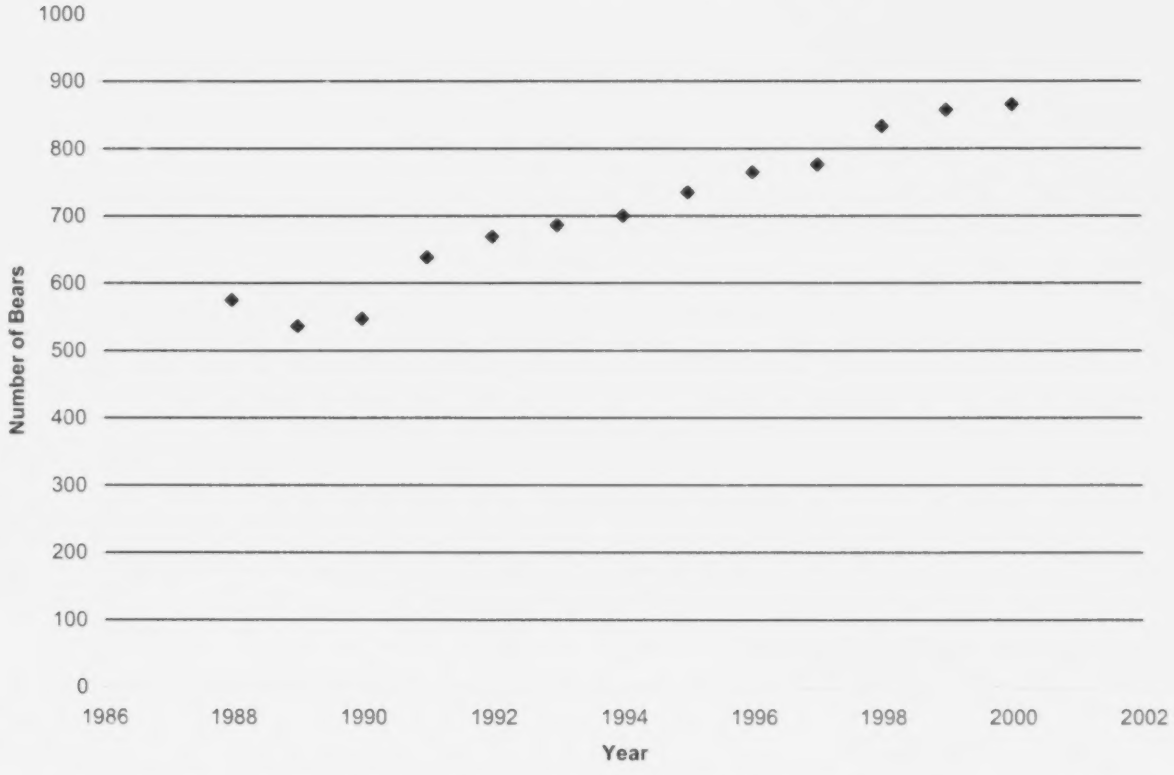

Figure 4. Estimated grizzly bear population on Alberta provincial land (excluding national parks) from 1988-2000.

Table 2. Total known mortality of grizzly bears by Alberta Bear Management Area (BMA), 1972 to 1999.

YEAR	BEAR MANAGEMENT AREAS (BMA)										
	1	2A	2B	3A	3B	4A	4B	4C	6&7	REM	TOTAL
1972	1	0	1	5	1	6	2	2	0	0	18
1973	1	0	0	10	0	1	1	2	0	2	17
1974	2	0	2	8	1	3	1	0	7	2	26
1975	1	1	3	7	0	6	2	0	0	1	21
1976	1	2	5	10	1	8	2	6	2	1	38
1977	3	1	6	6	1	8	3	4	0	0	32
1978	0	2	6	6	1	3	4	4	0	1	27
1979	1	1	4	8	1	7	1	5	4	1	33
1980	1	1	5	4	1	11	3	11	0	1	38
1981	5	1	6	8	2	7	2	12	1	2	46
1982	3	2	11	12	1	6	2	5	5	1	48
1983	6	2	7	9	2	14	0	12	8	0	60
1984	3	1	10	7	1	15	6	6	9	1	59
1985	1	1	9	9	0	18	5	6	5	1	55
1986	3	1	10	6	0	12	6	6	7	0	51
1987	2	4	11	2	2	10	6	12	14	5	68
1988	6	1	2	2	0	0	0	2	4	0	17
1989	1	2	9	1	0	0	2	1	2	2	20
1990	7	2	6	1	1	3	2	6	4	0	32
1991	4	1	2	2	0	0	3	2	2	1	17
1992	4	1	7	1	2	2	1	6	4	2	30
1993	2	1	2	2	1	11	3	2	5	1	30
1994	1	1	5	0	1	3	0	0	2	2	15
1995	0	1	2	2	1	2	2	1	2	1	13
1996	3	3	7	6	0	3	3	2	1	0	28
1997	4	1	6	0	4	1	0	1	3	0	20
1998	4	3	3	4	0	1	2	1	2	3	23
1999	1	1	6	9	0	1	5	3	5	5	36

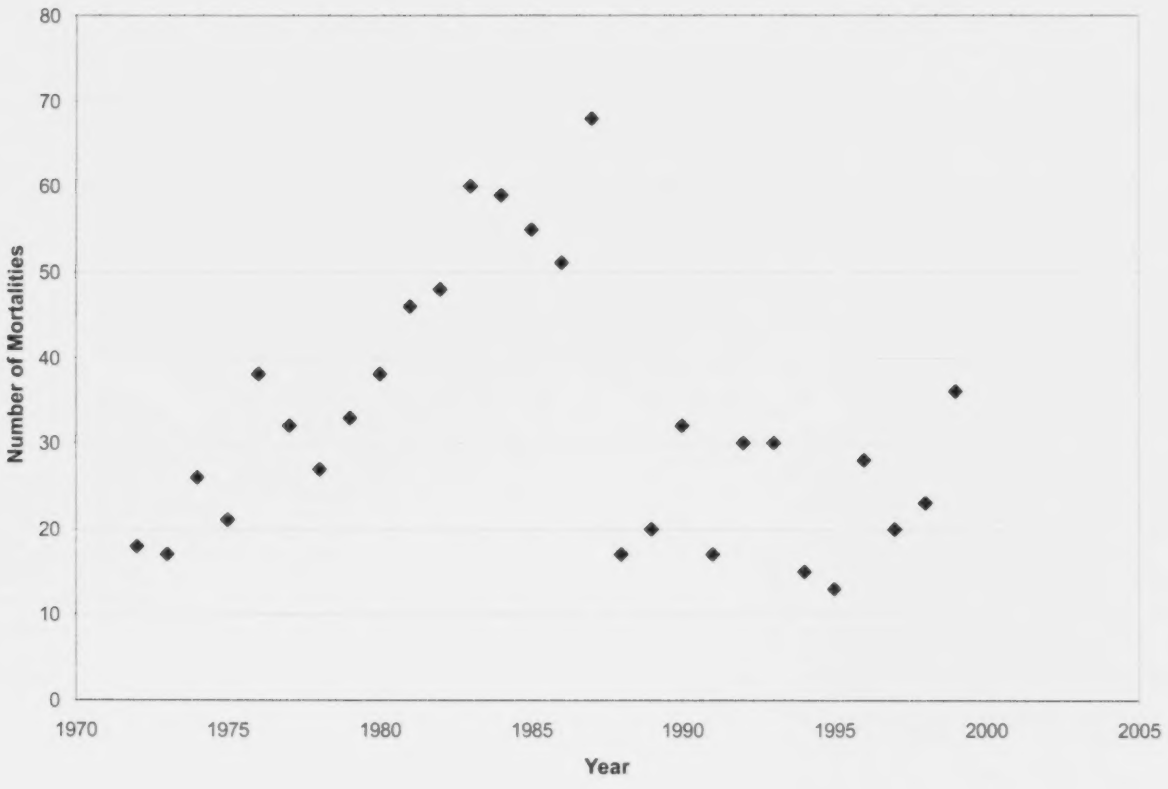

Figure 5. Trends in reported human-caused mortality of grizzly bears in Alberta (1972-1999).

BMA 13 (central and southern agricultural fringe areas), BMA 16 (northeastern Alberta) and the White Goat, Siffleur and Ghost River Wilderness Areas.

Based on Alberta Sustainable Resource Development's annual updates, BMAs with recorded decreases in grizzly bear numbers are 2A (-68%) and 6/7 (-31%). BMA 7 and 2A are considered to be secondary grizzly bear range in Alberta (Alberta Fish and Wildlife Division 1990). BMA 7 is located in the montane and foothills parkland of southwestern Alberta and comprises WMUs 300, 302, 304, 305, 306, 308, 310, 312 and 314. BMA 2A is found primarily in boreal mixedwood and lower foothills regions of northwest Alberta. BMA 6 is primary grizzly bear range and is located in the mountains of southwestern Alberta encompassing WMUs 400 and 402. It is contiguous with and lies west of the southern half of BMA 7.

Total known mortality records have been kept since 1972 (Table 2). Reported mortality rose steadily from 1972 and peaked in 1987. Mortality levels have decreased significantly in most BMAs since limited entry draws for grizzly bear hunting were extended province-wide in 1989.

Original (1988) population estimates calculated by Alberta Fish and Wildlife were based on conservative extrapolation from empirical research studies. Annual changes to the original estimates were based on known population biology of grizzly bears (Alberta Fish and Wildlife Division 1990). Nonetheless, there are several possible sources

of error associated with the assumptions inherent in these estimates. The 25% unreported kill level used is at the low end of estimates from published papers (Banci 1991, McLellan et al. 1999). These and other possible scientific issues notwithstanding, it is the only systematic effort to assess the status of grizzly bear populations over large areas of the province.

There have been three recent population research efforts that have shed some light on current grizzly bear population status in Alberta. Gibeau and Herrero (1998) reported on an estimate of the density of grizzly bears in Banff National Park and Kananaskis Country (4000 km^2) in the summer of 1996 using a DNA-based hair snagging approach (modified from Sherry 1996). A density estimate of 12 to 14 grizzly bears/1000 km^2 was calculated although it was made clear that data were too sparse to consider this estimate to be useful for management purposes. It is interesting to note that this estimate, although preliminary, is almost identical to the estimate of 12.2 to 14.5 grizzly bears per 1000/km^2 calculated by Carr (1989). It is slightly less than the value of 14.7 bears/1000 km^2 used by Alberta Fish and Wildlife Division (1990) for their original baseline population densities for the southern montane/subalpine/alpine.

A similar approach was used for a 5030 km^2 study area in the mountains, foothills and parkland of southwestern Alberta (Mowat and Russell 1998). In this study a density of 14.7 grizzly bears/1000 km^2 was calculated, identical to the original estimate for this region by Alberta Fish and Wildlife Division (1990). These authors indicated that the calculated estimate could be high by approximately 10% because of bear movement in and out of the study area. If this were the case, the modified estimate would lie within the range reported by Gibeau and Herrero (1998). Mowat and Russell's (1998) study area is representative of much of BMA 6 and 7. At the time of the publication of their findings, Alberta Sustainable Resource Development was estimating a total of 31 grizzly bears in the 14 128 km^2 land area occupied by BMAs 6 and 7. This amounts to a 1998 density estimate of 2.2 grizzly bears/1000 km^2. This is much lower than the empirical density findings of Mowat and Russell (1998) and is indicative of the conservative nature of Alberta Sustainable Resource Development's annual population update model. Based on the new findings by Mowat and Russell (1998), Alberta Sustainable Resource Development increased their 1998 population estimate for BMAs 6/7 to 57 from 31 (Table 1).

During 1999 and 2000, another estimate of grizzly bear population density was initiated using hair capture and DNA fingerprinting techniques in the Yellowhead region (Stenhouse 2000, Stenhouse and Munro 2001). This 5352 km^2 study area consists of predominantly subalpine and upper boreal habitats and straddles provincial and national park lands. A density estimate of 14.9 bears/1000 km^2 was calculated. This estimate is almost three times the 5.0 bears/1000 km^2 used for the original (1987) population estimates by the Alberta Fish and Wildlife Division (1990) for this area. The provincial portion of Stenhouse's (2000) study area encompasses the majority of provincial BMA 4B. As of 2000, Alberta Sustainable Resource Development estimated a total of 44 grizzly bears in the 6089 km^2 land area occupied by 4B. This amounts to a year 2000 density estimate of 7.2 grizzly bears/1000 km^2. This density is one-half of the minimum empirical density estimate reported by Stenhouse and Munro (2001), further supporting the conservative nature of Alberta Sustainable Resource Development's estimates of population size.

The current population density estimates as calculated by Alberta Sustainable Resource Development for licence allocation purposes appear to be consistent with or less than recent empirical estimates using DNA-based hair snagging techniques. These findings could reflect overly conservative original (1988) population estimates and stable populations in these study

areas. They could also reflect grizzly bear populations that are increasing at a greater rate than predicted by the annual updates conducted by Alberta Sustainable Resource Development. Since the techniques used to compare grizzly bear population densities between the late 1980s and late 1990s differ markedly, it is difficult to be certain of trends in populations. Continued DNA-based hair snagging projects offer the most accurate and cost-effective population estimates and as such should be continued over space and time to monitor trends in Alberta's grizzly bear populations.

2. Other Areas. - Population densities of grizzly bears are influenced by regional biogeoclimatic conditions and latitude (Picton et al. 1986, Fuhr and Demarchi 1990). For example, moist, temperate regions with significant topographic variability have the inherent capacity to support more bears per unit of land area than Cold Taiga Plains that have limited food and cover. This is reflected in the wide range of population densities observed across Canada as well as within Alberta.

The status of grizzly bears in Canada was reviewed in 1990 (Banci 1990). Twelve grizzly bear zones were designated that maintain current bear populations. Population densities in these zones were as follows:

ZONE	POPULATION DENSITY (#/1000 KM^2)
Arctic Coastal Plains	3.8
Taiga Shield	1.7
Taiga Plains	2.7
Subarctic Mountains	6.4
Subarctic Mountains and Plains	15.3
Cold Boreal Plains	3.3
Cold Moist Mountains	31.8
Temperate Wet Mountains	20.5
Cool Moist Plateaus	8.6
Cool Moist Mountains	19.6
Hot Dry Plateaus	2.1
Cool Dry Mountains	17.9

Alberta grizzly bear populations occur within four zones: the Taiga Plains, Cold Boreal Plains, Cool Moist Mountains, and Cool Dry Mountains. The Taiga Plains and Cold Boreal Plains roughly encompass BMAs 1, 2A, 2B, 3A, 3B, 13, and 16. The combined land area of these BMAs is 273 071 km^2. Alberta Sustainable Resource Development's 2000 population estimate for this region is approximately 600 grizzly bears, yielding a density of 2.1 bears per 1000 km^2. This is similar to the densities of 2.7 to 3.3 per 1000 km^2 identified by Banci (1991) for the Taiga Plains and Cold Boreal Plains. The Cool Moist Mountains zone occupies the northern Rocky Mountains and upper foothills of Alberta. This zone includes BMAs 4A, 4B and 4C. Combined, these three BMAs occupy 22 340 km^2 and support a 2000 population estimate of 168 bears. This yields a density of 7.5 grizzly bears/1000 km^2 which is considerably lower than the average of 19.6/1000km^2 reported by Banci (1991). The Cool Dry Mountains zone occupies Alberta BMAs 5, 6 and 7 and Waterton Lakes National Park. Recent grizzly bear densities of 14.7/1000 km^2 are slightly lower than the 17.9/1000 km^2 reported by Banci (1991).

The Cool Moist and Cool Dry Mountain zones straddle the Continental Divide between Alberta and British Columbia. The Alberta side of the Rocky Mountains is generally drier because of regional rain-shadow effect. Topography is also generally less rugged on the Alberta side of the Rockies. As a result, habitat conditions for grizzly bears are generally more favorable within the British Columbia portions of the Cool Moist and Cool Dry Mountain zones. This largely explains the lower population densities reported for Alberta's portion of these zones.

A similar east to west variability exists in grizzly bear population densities within the Northern Continental Divide Ecosystem of the northwestern United States. Reported population densities east of the Continental Divide (more typical of Alberta)

of this ecosystem range from 2.3 to 10.1 bears/ 1000 km^2 (Aune and Kasworm 1989). Studies in habitats west of the Continental Divide (more typical of British Columbia) reported grizzly bear densities of from 20.4 to 25.0/1000 km^2 (Servheen 1981, Mace and Waller 1997). Grizzly bear populations in British Columbia , including those along the British Columbia/Alberta border, are considered to be stable for the most part, although populations in the dry interior appear to be declining (D. Fraser, pers. comm.).

LIMITING FACTORS

1. General. - Historic reductions in grizzly bear populations were clearly related to extensive agricultural land conversion and unrestricted hunting. These two factors are less of an issue in contemporary grizzly bear management. Today, the primary limiting factors for grizzly bears in Alberta and elsewhere are human-caused mortality, unmitigated road access, and habitat loss, alienation and fragmentation.

Outside of the national parks, grizzly bears are vulnerable to hunting as well as habitat alteration and modification associated with multiple land uses. Grizzly bears compete with humans for space, game, and livestock (Jorgensen 1983, Knight and Judd 1983, Alberta Fish and Wildlife Division 1990, Mattson 1990). They are also potentially dangerous to humans (Herrero 1985). Thus when grizzly bears come into conflict with humans over space or resources, there is often an increased risk of mortality to bears and occasionally humans. With the exception of legal hunting mortality, there is presently no clear understanding of the relative risk of mortality posed to grizzly bears by various human activities, or of the threshold levels of land use beyond which grizzly bear populations decline. Recent work by Herrero et al. (2000) in the Central Canadian Rockies Ecosystem demonstrated that projected 4% growth of human populations in this region had potential to result in a significant grizzly bear population decline within a few decades.

Even inside national parks, undisturbed habitat is shrinking and grizzly bears are being displaced as a result of their interactions with human development and activity (Gibeau 2000). This is especially true in high-quality, low elevation Montane habitat (Gibeau et al. 1996). For example, during the period 1981 to 1996, Banff National Park exhibited the highest female mortality rate (81% of grizzly mortalities were females) reported for any grizzly bear population in the Central Rockies Ecosystem (Benn 1998). Grizzly bear home ranges often cross park boundaries onto provincial lands where hunting mortalities can occur. For example, Kootenay and Yoho National Parks have recorded relatively few grizzly bear mortalities within their boundaries (Benn 1998). However, bears known to use these parks frequently die in neighboring jurisdictions (Raine and Riddell 1991).

High levels of human use on roads potentially causes grizzly bear mortality, habitat avoidance, and vehicle-related mortalities (Mattson et al. 1987, McLellan and Shackleton 1988, McLellan 1989, B.C. Ministry of Environment, Lands and Parks 1995, Gibeau et al. 1996). Roads and associated human use can lead to habitat fragmentation, bear displacement, localized zones of high mortality, and increasingly disjunct populations, all of which lead to a potential reduction in gene flow and population declines (Gibeau 1998). Spatial analyses of grizzly bear mortality locations in the Central Rockies Ecosystem showed that most bears died within a few hundred metres of roads and trails (Benn 1998). The effect of roads encompasses all major land uses including transportation, forestry, oil and gas, mining, motorized and nonmotorized recreation, hunting and other uses.

The effects of several major factors limiting grizzly bear populations are discussed below.

2. Human-Caused Mortality. - Excessive human-caused mortality, especially of adult females, is the primary factor limiting grizzly bear

populations (Knight and Eberhardt 1985, Knight et al. 1988, Mattson 1993). Mortality data from around North America exhibit the same characteristics-human-related causes are the primary sources of grizzly bear mortality. Historical works (Storer and Tevis 1955, Noble 1972, Nielsen 1975, Young and Beyers 1980, McCrory and Herrero 1982, Brown 1985) consistently note that grizzly bears usually died as a result of some interaction with humans. Much of current grizzly bear research attempts to link the type and degree of human land use with mortality (McLellan and Shackleton 1988, Mattson et al. 1992, Gibeau et al. 1996). McLellan et al. (1999) recently determined that 77% to 85% of mortalities of radio-collared grizzly bears from 13 different studies were human-caused. Harris (1986) noted that total human-caused mortality rates of greater than 6.5% per year were not compatible with long-term grizzly bear population persistence.

Present attitudes towards this potentially dangerous animal (Herrero 1985) and competitor for food and space (Mattson 1990) challenge human - grizzly bear coexistence. Human-caused mortality outweighs natural mortality in southern parts of the grizzly bear range (Craighead et al. 1988, Carr 1989, McLellan 1989, Dood and Pac 1993, Gunson 1995, Gibeau et al. 1996, Benn 1998). In Alberta between 1972 and 1996, there were 838 recorded human-caused grizzly bear mortalities (Gunson 1995). Following is the breakdown of reported human-caused grizzly bear deaths by cause in Alberta between 1972 and 1996.

Legal Harvest

It is required by law to register grizzly bears that have been harvested legally or otherwise. Legal hunting accounted for an estimated 65% of the total human-caused grizzly bear mortality in Alberta from 1972 to 1996. From 1988 to 1999 the relative proportion of legal hunting mortality was considerably lower at 54%. Recent decreases in the proportion of legal hunting mortality reflect more intensive management, specifically province-wide limited-entry draw restrictions completed by 1988. Annual harvests during the 1970s varied between nine and 25 grizzly bears (Gunson 1996). Harvest mortality peaked at about 43 per year from 1983 to 1987. With the province-wide implementation of limited-entry hunting, legal harvest deaths declined to about 12 per year by 1996 (Gunson 1996). From 1997 to 1999 an average of 13 grizzly bears per year were legally harvested. A legal hunting mortality rate target of 4% has been suggested to maintain a stable grizzly bear population (Alberta Fish and Wildlife Division 1990, B. C. Ministry of Environment, Lands and Parks 1995). The Alberta government set a goal of a 2% current harvest mortality rate with the possible option of increasing this rate to 4% when the provincial population increases to 1000 animals (Alberta Fish and Wildlife Division 1990). Based on Alberta Sustainable Resource Development population estimates, the legal hunting mortality rate from 1988 to 1999 ranged from 0.7% to 3.5% (mean = 1.8%).

An appropriate sex ratio of the kill is an important requirement for long-term stable grizzly bear populations in areas with legal hunting (Bunnel and Tait 1985). It is generally accepted that the ratio of females in the annual harvest must be less than from 33% to 35 % (Harris 1986, B. C. Ministry of Environment, Lands and Parks 1995). From 1989 to 1999 the average proportion of females in the legal kill in Alberta has been 33.8% (H. Carr, pers. comm.).

Illegal Kill

A number of illegal activities (poaching, misidentify as black bear, self-defence, hunting infractions, too young, unnecessary killing) made up about 13% of all grizzlies killed between 1972 and 1996. Self-defence kills made up slightly over half of illegal deaths (7% of total). Most self-defence kills occur during the fall big game hunting period (Benn 1998). Due to the nature of the activity, an unknown number of illegal kills undoubtedly go undetected.

Agency Control
Problem wildlife control situations accounted for approximately 9% of all mortalities, including long-distance translocations that remove additional bears from specific populations. Recording of this cause of death is probably accurate, particularly in recent times, which have supported improved record keeping.

Treaty Indian
Treaty Indians were responsible for the deaths of about 4% of all grizzlies killed between 1972 and 1994. Most of these deaths were either hunting-related or problem wildlife control actions on Indian Reserve lands. This likely under-represents actual deaths by some unknown extent.

Other
Railway and highway accidents, accidental trapping by registered trappers, research mortalities, and incidental poisonings in wolf control programs accounted for the remaining (9%) reported human-caused mortalities.

Unreported Mortality
A portion of the total human-caused mortality in any grizzly bear population goes unreported. This can result from poaching, collisions with vehicles, and misidentification during hunting kills. Banci (1991) stated that non-hunting kills of grizzly bears have been under-represented in every jurisdiction in western Canada, and estimates of unreported kills in British Columbia ranged from 25-100% of the total kill. Since then, McLellan et al. (1999) synthesized mortality data from 13 radio-telemetry studies in Alberta, British Columbia, Montana, Washington and Idaho. They observed that in remote areas with legal hunting, managers would likely be aware of >70% of the grizzly bears killed by people. However, the proportion of unreported mortality appears to increase in areas where legal hunting does not occur and grizzly bears and humans share habitat to a greater degree (McLellan et al. 1999). McLellan et al. (1999) reported that without radio-collared bears, only 46-51% of the mortalities in their study would have been documented. This number is largely influenced by data from Montana, where legal hunting does not occur. Nine of the 22 unreported deaths caused by humans were from Montana (McLellan et al. 1999). The British Columbia component of this data is more representative of the Alberta situation than is the Montana component. McLellan et al. (1999) noted that in British Columbia, management agencies would have missed 17-33% of mortalities of radio-collared grizzly bears. In Alberta, wildlife managers assume a 25% unreported mortality (Alberta Fish and Wildlife Division 1990) in their annual updates of population levels and hunting licence allocations. This appears to be in line with findings of McLellan et al. (1999).

3. Natural Mortality. - Natural survival rates for adult grizzly bears are consistently high (Knight and Eberhardt 1985, McLellan 1989). Young bears die more frequently of natural causes such as intraspecific aggression (Stringham 1983), accident (Nagy et al. 1983a), and nutrition-related causes (Nagy et al. 1983a, Knight et al. 1988). Natural mortality of grizzly bears, especially those beyond dependent age, is probably rare, and is not often detected. Known natural reported mortality amounted to <1% in the Central Rockies Ecosystem portions of Alberta and British Columbia (Benn 1998). In jurisdictions with no hunting, or with a portion of the area in protected status, known natural mortality accounted for 5.7% (27/477) of known mortalities in the Yellowstone Ecosystem (1959-87, Craighead et al. 1988); 5.4% (12/223) of known mortalities in the Northern Continental Divide Ecosystem (1980-95, Dood and Pac 1993); and 8.5% (11/129) of known mortalities in Banff and Yoho National Parks (Benn 1998). McLellan et al. (1999) found that 14 of 92 (15%) radio-collared grizzly bear mortalities resulted from natural causes and that 12 of these were females (10 adults, 2 subadults). Alberta Sustainable Resource Development allows for 6% natural mortality for annual modelling of population change (Alberta Fish and Wildlife Division 1990). This value lies

at the lower end of the range of values (5.4% to 15%) summarized above.

Intraspecific Aggression

Stringham (1980) found reference to fewer than 24 confirmed cases of intraspecific aggression leading to mortality. There have been two confirmed cases of grizzly bears killing one another in the Eastern Slopes Grizzly Bear Project (see Recent Management in Alberta section, below). The first was a 24- year-old female killed at a carcass by another bear, while the second involved a subadult bear being killed by an adult male (S. Herrero, pers. comm.).

Malnutrition

Nutrition is thought to be of primary importance as the majority of cub mortality probably occurs during denning and shortly after emergence. Rogers (1976) suggested that for black bears if a certain body weight isn't reached by adult females, embryo resorption may occur. Miller (1990) noted that most cub mortalities in south-central Alaska occurred in May and June. Some annual cub mortality rates from North America are: 38% at McNeil Falls (Glenn et al. 1976), 31% in south-central Alaska (1978-89, Miller 1990), 31% at Yellowstone National Park (1959-70, Craighead et al. 1974), 15% in the Flathead Drainage (1979-90, Hovey and McLellan 1996), and as high as 75% in the Canadian Arctic (Nagy et al. 1983b). A portion of these cub mortalities could have involved intraspecific killing.

Diseases and Parasites

A review of diseases and parasites of grizzly bears is given in LeFranc et al. (1987). Grizzly bears are not thought to be threatened by any known virulent diseases (Mattson et al. 1996). Disease is probably a minor cause of death in the Central Rockies Ecosystem at present (Benn 1998).

4. Habitat Loss and Fragmentation.- Much of the scientific literature on the effects of fragmentation on wildlife habitat deals with the biological consequences of the creation of habitat islands of different sizes, usually nested within a matrix of agricultural or other highly developed lands (Saunders et al. 1991). This traditional view of habitat fragmentation results typically from large-scale physical loss of habitat, or drastic and widespread habitat alteration. Widespread physical habitat loss associated with agricultural land conversion and settlement has occurred historically in Alberta in the prairie and parkland regions and continues to occur to a lesser extent at the interface of the forested and agricultural regions of the province. This loss of habitat has drastically changed or permanently eliminated much of the grizzly bear habitat east of the Rocky Mountains.

In the forested regions of Alberta, habitat effects on grizzly bears are associated more with alteration/change than permanent loss. Habitat alteration occurs primarily from forestry clearcutting, oil and gas exploration and development, utilities (power lines), recreational development, and rangeland clearing for livestock. There is evidence that temporary habitat modifications such as forestry clearcutting can be positive for grizzly bears that find high quality summer and fall forage in early- to mid-seral habitats (Zager 1980, Martin 1983, Waller 1992, Mace and Waller 1997). Obviously, mortality risk and sensory disturbance associated with these kinds of land-use changes and activities must be managed for the potential habitat benefit to be realized.

In addition to reducing total area of available habitat, habitat fragmentation also results in remnant blocks of available habitat that are isolated to varying degrees (Lovejoy et al. 1984, Saunders et al. 1991). McLellan (1992) describes two scales of habitat fragmentation that affect grizzly bears. At the sub-regional level, fragmentation may be caused by a disturbance, such as a network of highly used roads, that disrupts the willingness of individual bears to efficiently move between feeding areas. At the regional scale of fragmentation, regional movements along or across

major valley systems may be blocked, and interbreeding populations are cut off from each other. Automobiles and trains using major human transportation corridors either kill grizzlies directly or prevent passage (Gibeau and Heuer 1996).

As human use of the landscape increases, access by grizzly bears to seasonal concentrations of important foods can be restricted (Mace and Waller 1997, Eastern Slopes Grizzly Bear Project 1998). A land area may produce abundant food sources but grizzly bears may be unwilling to use the area because of high levels of sensory disturbance or mortality risk. This unwillingness of bears to use suitable habitat is termed habitat avoidance/alienation or effective habitat loss. It can be quantified to some extent through standardized measures of habitat effectiveness (Weaver et al. 1986, Gibeau et al. 1996, Kansas et al. 1997). The degree to which habitat is alienated from use by grizzly bears depends on a number of factors including the nature and intensity of the disturbance, extent of security cover, and the level to which grizzly bears have been habituated to the disturbance or protected from hunting. Other factors include habitat quality (attractivity) in the vicinity of the disturbance and season. Effective habitat loss is generally more severe in areas that allow hunting than in areas that don't (Mace and Manley 1993, Mattson 1993). Related to this, is the grizzly bear's need for habitat types that offer security cover. In hunted areas the importance of security cover becomes greater (Mattson 1993), which is reflected by higher disturbance ratings used in habitat effectiveness models for open versus closed vegetation cover areas (Weaver et al. 1986, USDA Forest Service 1990). Motorized and 24-hour activities are generally thought to exert a greater disturbance on grizzly bears than nonmotorized and daylight-only activities (USDA Forest Service 1990). Point source disturbances have generally been assigned wider zones of influence yet lesser ratings of disturbance than linear disturbances (Weaver et al. 1986, USDA Forest Service 1990). Bears are more likely to expose themselves to sensory disturbance and attendant mortality risk if high quality food sources are found within the zone of influence of disturbance.

Mattson (1993) introduced the concept of security areas, which he defined as "areas wherein bears can forage for 24-48 hours secure from human disturbance". Gibeau and Herrero (1998) reported that, for 28 radio-collared adult female grizzly bears in the central Canadian Rockies Ecosystem, an average of 69% of their suitable habitat was in secure status.

5. Fire, Fire Suppression and Timber Harvest.- Human changes to grizzly habitat may be beneficial or detrimental depending on the spatial and temporal dimensions of the disturbance. A positive influence of wildfire on grizzly bear habitat use has been observed both east and west of the Continental Divide in the Central Rockies Ecosystem. Hamer and Herrero (1983, 1987) observed that most grizzly bear feeding in the Cascade Valley of Banff National Park occurred in open or seral vegetation associations. The majority of bears feeding on buffaloberry, ants, hedysarum roots and blueberry were associated with early successional or edaphically controlled fire and avalanche communities. Hamer and Herrero (1987) also noted that grizzly bear habitat in Banff National Park had decreased as a result of fire suppression and offered the following statement in this regard:

> "Because the plant communities in grizzly bear feeding habitat often appeared to be succeeding to forest types determined to be unimportant to foraging bears, it seems that grizzly bear feeding habitat will decrease in the absence of recurring wildfire. If this is the case, an eventual decline in grizzly bear density is expected."

Raine and Riddell (1991) also observed that burns were a preferred habitat of radio-collared grizzly bears during the berry season in Kootenay and

Yoho National Parks. Other researchers outside of the Central Rocky Mountains have also noted the importance of wildfire to grizzly bears. For example, Zager et al. (1983) found that in Montana the canopy cover of six berry-producing shrubs was higher in burns of 35 to 70 years old than in old growth sites. Russell et al. (1979) felt that the low numbers of grizzly bears in Jasper National Park were in part a result of an absence of wildfire in that area since the turn of the century.

Fruits of berry producing shrubs are critical to grizzly bears during the late summer and autumn fattening or "hyperphagic" period (Hamer 1996a). In the Eastern Slopes of the central Canadian Rocky Mountains, the most important berry producing shrub is Canadian buffaloberry (*Shepherdia canadensis*). Recent autecological research on this plant species by Hamer (1996a) has shown that wildfires created early successional plant communities in which were recorded highest buffaloberry fruit production. Research findings by Hamer (1996b) also indicate that the root density and biomass of yellow hedysarum (*Hedysarum sulphurescens*) a primary food for grizzly bears during the early spring and late autumn periods (Hamer and Herrero 1983, Raine and Riddell 1991), are enhanced in burned areas. Early successional fire communities create open forest canopy, which was found to be the dominant variable enhancing both buffaloberry and yellow hedysarum production (Hamer 1996a, 1996b).

Achuff et al. (1996) concluded that fire prevention and suppression have significantly altered the fire regime of the Bow Valley, particularly in the Montane Ecoregion. Green et al. (1996) reported that prescribed fire in Banff National Park over the last decade has totalled only 40% of the long-term average acreage burned per decade. This has in turn lessened the availability of open canopy environments, and therefore reduced abundance of at least two major grizzly bear food items – buffaloberry and hedysarum (Hamer 1996a, 1996b). The overall effect that this may be having on grizzly bear populations is likely negative.

Certain forestry practices may simulate fire to some extent from the perspective of stimulating bear food production (Zager 1980, Martin 1983, Waller 1992). Some Alberta grizzly bear habitat model results have shown relatively high habitat suitability for shrub- and pole-sapling-dominated clearcuts of from 6 to 25 years old (Collister et al. 1995a, 1995b, Collister and Kansas 1997, Eastern Slopes Grizzly Bear Project 1998, Kansas and Collister 1999).

Some studies indicate disproportionate use of clearcuts by grizzly bears especially during the berry season (Mace and Waller 1997), although this has not yet been empirically determined in Alberta. Potential mortality related to forestry access roads must be taken into account when considering any habitat quality gains.

6. Habitat Carrying Capacity. - In the absence of human factors, maximum sustainable grizzly bear population density, or carrying capacity, in a given region is determined primarily by habitat quality (Edge 1985). Habitat quality is in turn controlled largely by biogeoclimatic conditions (Picton et al. 1986, Fuhr and Demarchi 1990). This is reflected in the wide range of grizzly bear population densities reported for each Alberta Natural Region/Sub-Region earlier in this status report. The maximum grizzly bear population that can be reasonably maintained is dictated by carrying capacity of the current habitat conditions. Human disturbance factors can reduce the inherent (habitat) carrying capacity of certain landscapes for grizzly bears (Mace and Waller 1997). On the other hand there may be potential in some landscapes to increase the habitat carrying capacity by improving habitat quality (e.g., prescribed fire, timber harvest). The current status of Alberta grizzly bear populations relative to carrying capacity is not clear. Further scientific investigations are warranted in this area.

7. Cumulative Effects and Landscape Condition Indicators. - Cumulative effects are defined as impacts on natural and social environments which: 1) occur so frequently in time or so densely in space that they cannot be assimilated, or 2) combine with effects of other activities in a synergistic manner (Sonntag et al. 1987). Grizzly bears are particularly prone to cumulative land use effects because of their inability to adapt to human disturbance. Cumulative effects assessment (CEA) for grizzly bears is an analysis of the total and interacting effects of human activities on bear populations, mediated through habitat (Mattson and Knight 1991). CEA for grizzly bears has taken place in Alberta since the mid-1990s in conjunction with both regional planning (Gibeau et al. 1996, Eastern Slopes Grizzly Bear Project 1998, Jalkotzy et al. 1998, Stenhouse 2000) and single-project (Herrero and Herrero 1996, Kansas et al. 1997, Kansas and Collister 1999a, 1999b, Kansas and Herrero 1999) assessments. These assessments attempt to determine the total effects of human use on habitat and populations through regional, landscape-modelling techniques.

Landscape condition indicators measured to assess cumulative effects on grizzly bears include the following: 1) habitat effectiveness; 2) security areas; 3) total human-caused and unknown mortality; 4) open road density, and 5) habitat connectivity. The ultimate goal is to establish region-specific thresholds for landscape condition indicators that are compatible with long-term grizzly bear population persistence (Northern East Slopes Environmental Resource Committee 2000). Research to determine threshold values for these indicators is currently being conducted in the Banff/Kananaskis region (Gibeau et al. 1996, Eastern Slopes Grizzly Bear Project 1998) and in the Yellowhead region (Stenhouse and Munro 2001).

STATUS DESIGNATIONS

1. Alberta. - The following points highlight the reported status of the grizzly bear as of 1985:

- Populations declined during the 1960s and increased since the 1970s.
- Estimate of population size in Alberta outside of the national parks was 500 to 1000.
- Long-range population goal of retaining a minimum of 1000 grizzly bears in Alberta including those that seasonally inhabit both Alberta and adjacent national parks, and British Columbia.
- Increase recreational hunting opportunities if populations allow.
- Maintain the 106 000 km^2 of grizzly range with emphasis on protecting key habitats (Alberta Fish and Wildlife Division 1984).

According to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001), the grizzly bear is considered "May Be At Risk" in the province (see Appendix 1 for status definitions). In 1991 and 1996, the grizzly bear was classified as a "Blue-List" species (Alberta Fish and Wildlife 1991, Alberta Wildlife Management Division 1996). This classification was based on the following points:

- Numbers have remained relatively stable outside the national parks since 1980 (1980 = 500 to 1000; 1989 = 600; 1996 = 765).
- The grizzly bear is sustaining its population under a very restricted sport-hunting regime.
- The greatest threat to grizzly bear populations is loss of wilderness habitats through resource extraction and recreational development.

The Alberta Natural Heritage Information Centre (2001) does not include the grizzly bear on their Species Tracking list.

2. Other Areas. - The grizzly bear's Global Heritage Status rank is G4T3T4 (sub-species indicated by T-rank; NatureServe 2001), meaning that it is apparently secure, although it may be rare in parts of its range. The prairie population (Alberta, Manitoba, Saskatchewan) of grizzly bears is listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as "Extirpated" (COSEWIC 2001). Within its known current distribution in Canada, the grizzly bear is listed as a "Special Concern" species by COSEWIC (2001). *The General Status of Species in Canada* lists the grizzly bear as nationally "Sensitive" as well as "Sensitive" in the Yukon, Northwest Territories, Nunavut and British Columbia, "Status Undetermined" in Saskatchewan and "Extirpated" in Manitoba (Candian Endangered Species Conservation Council 2001). The B.C. Ministry of Environment, Lands and Parks (2001) ranks the grizzly bear in British Columbia as S3, "Blue-Listed," meaning that it is thought to be vulnerable in that province because of sensitivity to human activities or natural events. In Manitoba, the grizzly bear is listed SX, meaning it is believed to be extirpated (Manitoba Natural Resources 1999).

The grizzly bear is listed as "Threatened" in the contiguous United States, and is protected and managed under the U.S. *Endangered Species Act* (U.S. Fish and Wildlife Service 2001). In the state of Washington, the grizzly bear is ranked as S1 (see Appendix 1 for status definitions) and is listed as "Endangered" (Washington Natural Heritage Program 2001). It is ranked as S1 and listed as "Threatened" in Idaho (Idaho Conservation Data Center 2001) and S2 in Wyoming (Wyoming Natural Diversity Database 2001). In Montana, the grizzly bear is ranked as S1S2 (Montana Natural Heritage Program 2001).

RECENT MANAGEMENT IN ALBERTA

The future status of grizzly bears in Alberta hinges on effective land management guided by scientific understanding (Mattson et al. 1996, Herrero et al. 1997). Managing multiple land use impacts on a wide-ranging, sensitive species such as the grizzly bear requires cooperation between government, industry and public stakeholders that results in effective mitigative actions on the ground (Northern East Slopes Environmental Resource Committee 2000). It also requires a scientific understanding of the types and levels of impact that are compatible with long-term persistence of grizzly bear populations (Mattson and Knight 1991). Considerable strides have been made in the last decade toward improving inter-stakeholder cooperation and research understanding. Many of these improvements have resulted from public debate surrounding the legislated need for cumulative effects assessment (Hegmann et al. 1999) of single-project proposals (Natural Resources Conservation Board 1993a, Natural Resources Conservation Board 1993b, Alberta Energy Resources Conservation Board 1994, AEUB-CEAA Joint Review Panel 1997) and regional planning (Banff-Bow Valley Study 1996) in the foothills and mountains of Alberta.

The formal planning of management activities for grizzly bears in Alberta is guided by the *Management Plan for Grizzly Bears in Alberta* (Alberta Fish and Wildlife Division 1990). This plan provides detailed documentation of historical populations and management, biology and life history requirements, the population and distribution status of the species as of 1989, and factors affecting population status at that time with a focus on regional analysis of mortality. Bear Management Areas (BMAs) have been delineated in Alberta and form the framework for regional grizzly bear management. A management plan is provided including a policy framework, management goals and objectives, and

management strategies. The primary challenge of Alberta's grizzly bear management since the publication of the plan has been to increase the provincial population to 1000 bears, from the 1987 estimate of 790 (including national parks). Provision of increased opportunity for Albertans to observe and enjoy grizzly bears and maintain effective responses to grizzly-human conflicts were listed as secondary challenges.

The following specific management goals were presented in Alberta Fish and Wildlife Division (1990):

1. To ensure the provincial grizzly bear resource is protected from irreversible decline.
2. To maximize benefits to Albertans through the optimum allocation of the grizzly bear resource amongst esthetic, recreational, commercial and other users.
3. To maximize the recreational benefits and enjoyment to Albertans from the grizzly bear resource through the provision of a variety of recreational opportunities.
4. To maximize the commercial benefits to Albertans from the grizzly bear resource.
5. To minimize property damage and other hazards to humans caused by grizzly bears.
6. To promote and encourage scientific and educational activity to enhance knowledge and appreciation of grizzlies.

Less formalized, ad-hoc or "pilot" planning activities have also taken place for the purposes of grizzly bear management. These are cooperative, committee-based research or management activities that are driven by specific management concerns or are spin-offs of regional grizzly bear environmental impact assessment, research or ecosystem management. Examples include the following:

1. The Eastern Slopes Grizzly Bear Project. In 1994, this long-term grizzly bear research project was initiated in the Central Rocky Mountains. The goal of this project is to provide data required for the three principal components (habitat quality, human disturbance and mortality risk) of a comprehensive cumulative effects assessment on regional grizzly bear populations (Herrero et al. 1997). A steering committee made up of representatives of federal and provincial government agencies, the oil and gas industry, the forest industry, the cattle industry, the development and tourism industry, and environmental groups guides research and is currently discussing integrated land use planning approaches for grizzly bear population and habitat management. Research information from this project has been provided to the Banff Bow Valley Task Force Study as well as the Kananaskis Country Recreational Policy Review Planning Process. Research products are in the form of several post-graduate theses from the University of Calgary (Benn 1998, Gibeau 2000, J. Kansas, in press).

2. The Rocky Mountain Grizzly Bear Planning Committee (RMGBPC). - This committee was formed in 1997 to address issues relating to the trans-boundary management of grizzly bear populations. This committee is made up of representatives from federal and provincial governments and includes representatives from the United States. The RMGBPC is mandated to advise and to make recommendations to the provincial ministers responsible for wildlife management in British Columbia and Alberta, to the federal minister responsible for national parks and to the Northern Continental Divide Ecosystem Subcommittee of the Interagency Grizzly Bear Committee. Specific issues under consideration by this committee's mandate are as follows:

- identification of proposed grizzly bear Management Areas (GBMAs)
- management objectives for GBMAs

- facilitation of interagency cooperation in the management of grizzly bear populations
- integration of land use objectives
- identification of research and inventory needs
- monitoring of grizzly bear status and trends
- monitoring and promoting effective management of human-bear conflicts
- proposing and promoting new management programs and strategies

3. The Yellowhead Ecosystem Carnivore Working Group. - The purpose of this group is to "use existing information and knowledge on carnivore populations in the Yellowhead region to develop proposals for management programs, and to identify information needs to ensure the long-term conservation of these species, by providing opportunities for all partners to work together in addressing landscape/ecosystem management issues." Specific objectives of this group include the following:

- compile existing data and information on focus species within the Yellowhead region
- identify management issues and define data and information gaps
- recommend management activities, when possible, based on current level of knowledge available, concerning the species in question
- suggest and coordinate research, inventory and monitoring programs on carnivores within the Yellowhead region
- communicate and promote cooperation with other groups and researchers involved

4. Southwestern Alberta Grizzly Strategy. - This regional strategy was developed in 1997 and was designed to maintain long-term grizzly bear populations while protecting property owners from losses resulting from grizzly bear depredation. Specific activities of this strategy include:

- continuation of limited entry hunting in two licence areas (WMU 300 302 400; WMU 306 308 402) and closure of hunting in a newly created WMU in the Crowsnest Pass area
- encouragement of habitat securement in the Crowsnest Pass area to reduce future human/grizzly conflicts
- grizzly bear habitat improvement in high-elevation, low-depredation areas, including closure of vehicle access into potential grizzly use areas (e.g., high elevation logged areas)
- enhanced guidelines for problem grizzly bear translocation including monitoring of locally translocated bears; long distance removal of boar grizzlies on first occurrence of cattle depredation; translocation of sow and cub grizzlies to local areas on first depredation occurrence; and, translocation of sow and cub(s) to northern Alberta on second depredation
- increased use of negative conditioning (e.g., Karelian bear dogs, scare devices) especially in situations where bears are spending time in built-up areas where future problems are likely to occur
- increased use of preventative measures such as electric fencing and removal of attractants
- a road-kill carcass redistribution program to hold bears at high elevations during spring and thereby reducing livestock depredation
- information/education programs geared toward minimizing individual human-grizzly bear conflicts
- DNA-based hair snagging population estimates for the region (Mowat and Russell 1998)

5. A Strategic Framework for Grizzly bear Conservation in the Yellowhead Ecosystem (Northern East Slopes Environmental Resources Committee (NESERC)). - Stemming from the Cheviot Mine Project Application (1997), a working group with representatives from Alberta Sustainable Resource Development, Parks Canada and various industrial and recreational stakeholders was formed. Considerable discussion and refinements to this framework have occurred since its inception, leading to this group's stated objective: "To cooperatively manage for landscape and population conditions necessary to ensure the long-term persistence of a healthy population of grizzly bears within its current range in the Alberta-Yellowhead ecosystem." The Draft Strategic Framework (NESERC 2000) recognizes that suitable landscape conditions are necessary to maintain grizzly bear population size, health and distribution within the regional ecosystem. Five indicators of suitable landscape conditions are recognized including habitat effectiveness, security areas, total human-caused mortality, road density, and habitat connectivity. The Framework suggests that target and threshold values for each of these indicators must ultimately be set to guide management actions and to allow for the evaluation of trade-off decisions and costs. A Regional Carnivore Management Group consisting of representatives from various sectors has been formed to guide management activities.

6. Foothills Model Forest Grizzly Bear Research Program. - The "science" component of the Strategic Framework for Grizzly Bear Conservation in the Yellowhead Ecosystem, this research program was designed to provide resource managers with the necessary knowledge and planning tools to ensure the long-term conservation of grizzly bears in the Alberta Yellowhead Ecosystem (Stenhouse 2000). Specific program goals are as follows:

- to provide information that will support management programs to provide healthy and stable/increasing grizzly bear populations over time.
- to identify habitat and landscape conditions that contribute to or limit viable and regionally connected grizzly bear populations.
- to develop a set of validated, user-friendly, GIS-based computer models that will provide predictive capability when resource managers are making land use planning decisions in known grizzly bear range.
- to develop cost-effective techniques and approaches to aid in monitoring grizzly bear populations within the study area, but which ultimately may be transferable to all grizzly bear populations and habitats.

One year of research has been completed including delineation of Bear Management Units, radio-collaring and monitoring using Global Positioning System (GPS) technology, and a preliminary DNA-based hair-snagging population estimate (Stenhouse 2000). A Scientific Advisory Group has been formed to guide research approaches.

7. Boreal Grizzly bear Research Project. - A recently initiated research program designed to study grizzly bear ecology and population dynamics in the boreal region of northwestern Alberta.

8. The Alberta C5 Forestry Project. - The goal of this pilot project is to develop landscape ecology inventory and planning tools for integrated forest management. Grizzly bear habitat mapping and evaluation has been implemented over a 5030 km^2 study area in the southern east slopes of the Rocky Mountains.

Research studies of the grizzly bear have occurred in 10 localities in Alberta since 1975 and are currently ongoing in three areas.

SYNTHESIS

Agricultural land conversion and human settlement eliminated grizzly bears from much of the prairies and lower foothills of Alberta by the late 1800s. By the 1960s, hunting restrictions and improved land use management policies had significantly reduced the high levels of grizzly bear mortality and habitat loss in Alberta. After a suspected increase in grizzly bear populations by the early 1970s, recreational hunting mortalities increased to unsustainable levels by the mid-1980s. In 1988, the Alberta government extended the limited-entry draw system across the province, reducing mortality significantly in most areas.

Population trend analyses by Alberta Sustainable Resource Development indicate that the population of grizzly bears in the province of Alberta (outside national parks) has increased from 575 animals in 1988 to an estimated 841 in 2000. According to these analyses, grizzly bear populations have increased in all three provincial Bear Management Areas (BMAs). The largest estimated increases have occurred in the northern Rocky Mountains and foothills regions where human population density is low and agricultural land use is limited. Estimated increases are due primarily to reductions in legal hunting mortality resulting from province-wide implementation of limited-entry draw hunting restrictions in 1988. The three Bear Management Areas with predicted decreases in grizzly bear populations are located in the mountains and foothills parkland of southwestern Alberta (BMA 6 and 7) and in the Peace River Parkland and Dry Boreal Mixedwood Natural Su-Regions (BMA 2A). These secondary ranges are characterized by extensive agricultural land use and high human population or use levels. Reductions in these areas were a result of problem bear translocations and kills related to livestock/agricultural and personal property damage complaints.

Recent DNA fingerprinting studies indicate that current estimates of grizzly bear populations as calculated by Alberta Sustainable Resource Development are conservative. In southwestern Alberta (i.e., BMA 6 and 7) DNA-based density estimates were six times those based on population projections by Alberta Sustainable Resource Development. In primary grizzly bear range east of Jasper National Park, DNA-based density estimates were three times higher than Alberta Sustainable Resource Development estimates. Low human-caused mortality rates in most BMAs suggest populations have been increasing since 1988. There is no evidence to suggest a decreasing provincial population since 1988. Additional DNA-based hair-snagging studies should be completed in other BMAs to determine population status and trend.

In spite of recent successes in grizzly bear population management in Alberta, longer-term threats to this inherently sensitive species continue to mount. The most serious threat to Alberta grizzly bear populations is uncontrolled human-caused mortality mediated through poorly managed access and human activity. It is clear throughout North America that increasing human populations and access into grizzly bear range eventually leads to levels of mortality and habitat alienation sufficient to extirpate grizzly bear populations. It is inevitable that human population densities and access into grizzly bear range will continue to increase in Alberta. The extent to which these continued pressures affect grizzly bear populations will depend on the degree to which management interventions are successful at limiting mortality risk and habitat alienation of grizzly bears. Key management interventions include the following: 1) continuation of limited-entry draw hunting restrictions; 2) access management in multiple use areas; 3) intensive management to reduce problem bear conflicts in agricultural areas; and 4) intensive management of human activity, especially in high quality grizzly bear habitat.

Direct and indirect impacts on grizzly bears from both recreational and industrial land uses have the potential to accumulate beyond thresholds that can be assimilated by grizzly bear populations. Threshold levels for landscape condition indicators such as open road densities, security areas and habitat effectiveness have been established in the northwest United States. Considerable research effort is being placed on establishing thresholds beyond which Alberta landscapes would no longer provide acceptable habitat for long-term grizzly bear population persistence. This includes two major studies in the mountains and foothills of the central and northern Rocky Mountains. Active cooperation between government, industry and the public will be required to support these studies and to understand their implications to shared land use activities.

LITERATURE CITED

Achuff, P. L., I. Pengally and J. Wierchowski. 1996. Banff Bow Valley Study – vegetation module Progress Report. Banff, Alberta.

AEUB-CEAA (Alberta Energy and Utilities Board-Canadian Environmental Assessment Agency) Joint Review Panel. 1997. Report: Cheviot Coal Project. 161 pp.

Alberta Energy Resources Conservation Board (ERCB). 1994. Application for an exploratory well, Amoco Canada Petroleum Company Limited - Whaleback Ridge area. ERCB decision rept. 94-8, Calgary, AB. 6 pp.

Alberta Environmental Protection. 1994. Natural Regions and Sub-Regions of Alberta: Summary. 18 pp.

Alberta Fish and Wildlife. 1985. A policy for the management of threatened wildlife in Alberta. Alberta Fish and Wildlife, Edmonton, AB. 34 pp.

Alberta Fish and Wildlife. 1991. The Status of Alberta Wildlife. Alberta Forestry, Lands, and Wildlife, Wildlife Management Branch, Edmonton, AB. 49 pp.

Alberta Fish and Wildlife Division. 1990. Management Plan for Grizzly Bears in Alberta. Wildlife Management Planning Series Number 2. Alberta Forestry, Lands and Wildlife, Edmonton, AB. 164 pp.

Alberta Fish and Wildlife Division. 1991. Management plan for wolves in Alberta. Wildlife Management Planning Series No. 4. Alberta Forestry, Lands and Wildlife, Edmonton, AB. 89 pp.

Alberta Fish and Wildlife Division. 1993. Management plan for black bears in Alberta. Wildlife Management Planning Series No.10. Alberta Forestry, Lands and Wildlife, Edmonton, AB. 116 pp.

Alberta Fish and Wildlife Management Division. 1984. Status of the fish and wildlife resource in Alberta. Alberta Fish and Wildlife, Edmonton, AB. 127 pp.

Alberta Natural Heritage Information Centre. 2001. Elements on the Tracking List. Alberta Natural Heritage Information Centre. URL: http://www3.gov.ab.ca/env/parks/anhic/anhic.html [Revision date: 6 April 2001].

Alberta Sustainable Resource Development. 2001. The General Status of Alberta Wild Species 2000. Alberta Sustainable Resource Development, Fish and Wildlife Service, Edmonton, AB. 46 pp.

Alberta Wildlife Management Division. 1996. The Status of Alberta Wildlife. Alberta Environmental Protection, Wildlife Management Division, Edmonton, AB. 44 pp.

Aune, K. and W. Kasworm. 1989. Final report: East Front grizzly studies. Montana Department of Fish, Wildlife and Parks. 332 pp.

Banci, V. 1991. The status of the grizzly bear in Canada in 1990. Committee On the Status of Endangered Wildlife in Canada (COSEWIC), Ottawa, ON. 171pp.

Banff-Bow Valley Study. 1996. Banff-Bow Valley: At the Crossroads. Summary report of the Banff-Bow Valley Task Force (Robert Page, Suzanne Bayley, J. Douglas Cook, Jeffrey. E. Green, and J.R. Brent Ritchie). Prepared for the

Honourable Sheila Copps, Minister of Canadian Heritage, Ottawa, ON. 76 pp.

Barrett, M. W., J. A. Nagy, A. W. Hawley, and J. W. Nolan. 1983. Selection and characteristics of grizzly bear dens in west-central Alberta. Alberta Environment Centre, Vegreville, AB.

B.C. Conservation Data Centre. 2001. Tracking Lists. British Columbia Ministry of Environment, Lands and Parks. URL: http://www.elp.gov.ab.ca/rib/wis/cdc/ [Revision date: 19 April 2001].

B.C. Ministry of Environment, Lands and Parks. 1995. Conservation of Grizzly Bears in British Columbia-Background Report. Ministry of Environment, Lands and Parks, Victoria, BC. 70 pp.

Benn, B. 1998. Grizzly bear mortality in the Central Rockies Ecosystem, Canada. M. E. D. thesis. University of Calgary, Calgary, AB. 151 pp.

Blanchard, B. M. and R. R. Knight. 1991. Movements of Yellowstone Grizzly Bears. Biol. Conserv. 58:41-67.

Brown, D. E. 1985. The grizzly bear in the Southwest. University of Oklahoma Press. Norman, OK. 274 pp.

Bunnel, F. L. and D. F. N. Tait. 1985. Mortality rates of North American bears. Arctic 38:1316-1323.

Canadian Endangered Species Conservation Council (CESCC). 2001. Wild Species 2000: The General Status of Species in Canada. Ottawa: Minister of Public Works and Government Services of Canada.

Carr, H. D. 1989. Distribution, numbers and mortality of grizzly bears in and around Kananaskis Country, Alberta. Wildlife Research Series No. 3. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, Edmonton, AB. 49 pp.

Cheviot Mine Application. 1996. Cardinal River Coals Ltd. 1996a. The Cheviot Mine project application. Prepared by Cardinal River Coals Ltd., Hinton, AB.

Collister, D. M., J. L. Kansas, and R. G. Usher. 1995a. Wildlife habitat assessment: Moose Mountain environmental inventory. Unpubl. Rept. prepared for Husky Oil by GAIA Consultants Inc., Calgary, AB. 68 pp.

Collister, D. M., J. L. Kansas, and W. K. Brown. 1995b. Sherman Management Area Ecological Project: Wildlife. Unpubl. Rept. prepared for Weyerhaueser Canada, Grande Prairie, AB. 48 pp.

Collister, D. M., and J. L. Kansas. 1997. McLean Creek Forest Ecosystem Management Project.: Terrestrial Component. Unpubl. Rept. prepared for Spray lake Sawmills by URSUS Ecosystem Management Ltd. Calgary, AB. 151 pp.

COSEWIC. 2001. Species at Risk in Canada. Committee on the Status of Endangered Wildlife in Canda. URL: http://www.speciesatrisk.gc.ca/Species/sar/main.htm [Revision date: 27 April 2001].

Cowan, I. M. 1972. The status and conservation of bears (Ursidae) of the world - 1970. Int.Conf.Bear Res.and Manage. 2:343-367.

Craighead, J. J., K. Greer, R. R. Knight, and H. I.Pac. 1988. Grizzly bear mortalities in the Yellowstone ecosystem. Wildlands Institute, Missoula, MT. 118 pp.

Craighead, J. J., M. G. Hornocker, and F. C. Craighead, Jr. 1969. Reproductive biology of young female grizzly bears. J. Reprod. Fertil. Suppl. 6: 447-475.

Craighead, J. J., and J. A. Mitchell. 1982. Grizzly Bear. Pp. 515-556 in Wild animals of North America: biology, management and economics. (J. A. Chapman and G. A. Feldhamer, eds.). John Hopkins Univ. Press, Baltimore, MD.

Craighead, J. J., J. R. Varney, and F. C. Craighead, Jr. 1974. A population analysis of the Yellowstone Grizzly Bears. Montana Forestry and Conservation Experiment Station Bulletin 40. Univ. Montana, Missoula, MT. 20 pp.

Dood, A. R., and H. I.Pac. 1993. Five year update of the programmatic environmental impact statement. The grizzly bear in northwestern Montana. Montana Dept. of Fish, Wildlife and Parks, Helena, MT. 228pp.

Eastern Slopes Grizzly Bear Project. 1998. Grizzly bear population and habitat status in Kananaskis Country, Alberta. Prepared for the Department of Environmental Protection, Natural Resources Service, Edmonton, AB. 71 pp.

Edge, W. D. 1985. Estimating carrying capacity of grizzly bear populations. Prepared for U. S. Fish and Wildl. Serv., Office of grizzly bear recovery coordinator, Missoula, MT. 16 pp.

Fuhr, B. L., and D. A. Demarchi. 1990. A methodology for Grizzly bear habitat assessment in British Columbia. Wildl. Branch Min. Envir., Victoria, BC. Wildl. Bull. # B-67. 28 pp.

Garshelis, D., M. Gibeau, and S. Herrero. 2001. Preliminary demographic analysis of eastern slopes grizzly bears through year 2000. Appendix 1. in A brief summary of the status of the Eastern Slopes Grizzly Bear Project (ESGBP). 9 pp.

Gibeau, M. L. 1998. Grizzly bear habitat effectiveness model for Banff, Yoho and Kootenay National Parks, Canada. Pp. 235-241 in Ursus: an official publication of the International Association for Bear Research and Management: a selection of papers from the 10th International Conference on Bear Research and Management, Fairbanks, Alaska, July, 1995 and Mora, Sweden, September, 1995 (S. D. Miller, and H. V. Reynolds, eds.). International Association for Bear Research and Management.

Gibeau, M. L. 2000. A conservation biology approach to the management of grizzly bears in Banff National Park. Ph.D. Thesis, University of Calgary, Calgary, AB.

Gibeau, M. L., S. Herrero, J. L. Kansas, and B. Benn. 1996. Grizzly bear population and habitat status in Banff National Park: report to the Banff Bow Valley Task Force, Banff, AB. 62 pp.

Gibeau, M. L., and S. Herrero. 1997. Eastern Slopes Grizzly Bear Project – Year 3 Project Report. Prepared for the Eastern Slopes Grizzly Bear Project Committee by the Eastern Slopes Grizzly Bear Project, University of Calgary, Calgary, AB. 18 pp.

Gibeau, M.L. and S. Herrero. 1998. Managing for grizzly bear security areas in Banff National Park and the Central Canadian Rocky Mountains. 11th International Conf. Bear Res. and Manage. (in press) URL: http://www.canadianrockies.net/Grizzly/securityiba.htm [Accessed: 15 October 2001].

Gibeau, M.L. and S. Herrero. 1999. Eastern Slopes Grizzly Bear Project - Year 5 Project report. Prepared for the Eastern Slopes Grizzly Bear Steering Committee by the Eastern Slopes Grizzly Bear Project. University of Calgary, Calgary, AB. 21 pp.

Gibeau M. L. and K. Heuer. 1996. Effects of transportation corridors on large carnivores in the Bow River Valley, Alberta. In Trends in addressing transportation related wildlife mortality. (G. L. Evink, P. Garrett, D. Zeigler, and J. Berry, eds.). Proceedings of the Transportation Related Wildlife Mortality Seminar, State of Florida, Dept. of Transportation. Env. Manage. Office. Tallahassee FL

Glenn, L. P., J. W. Lentfer, J. B. Faro, and L. H. Miller. 1976. Reproductive biology of female brown bears (*Ursus arctos*), McNeil River, Alaska. Pp. 381-390 in Bears, their biology and management: a selection of papers from the third International Conference on Bear Research and Management (M. R. Pelton, J. W. Lentfer, and G. E. Folk, eds.). International Union for Conservation of Nature and Natural Resources, Morges, CH.

Green, J., C. Pacas, S. Bayley and L. Cornwell. 1996. Ecological outlooks project. A cumulative effects assessment and futures outlook of the Banff Bow Valley. Prepared for the Banff Bow Valley Study. Department of Canadian Heritage, Ottawa, ON.

Gunson, J. R. 1995. Analysis of grizzly bear mortalities in Alberta during 1972-1994. Alberta Wildlife Management Division Occ. Paper No. 16. Alberta Environmental Protection, Edmonton, AB. 101pp.

Gunson, J. R. 1996. Analysis of the limited-entry grizzly bear hunts in Alberta during 1988-1996. Alberta Wildlife Management Division Occ. Paper No. 17. Alberta Environmental Protection, Edmonton, AB. 18 pp.

Gunson, J. R. 1997. Bears in Alberta: their characteristics, history, behaviour and management. Alberta Environmental Protection, Natural Resources Service, Edmonton, AB Pub. No. I/646. 24 pp.

Gunson, J. R., and P. J. Cole. 1977. Biological observations of black bears captured following beeyard and other depredations. Alberta Fish and Wildlife, Edmonton, AB. 17 pp.

Hamer, D. 1996a. Buffaloberry (*Shepherdia canadensis*) fruit production in fire-successional bear feeding sites. Banff National Park, Banff, AB. 59 pp.

Hamer, D. 1996b. Wildfire's influence on Yellow Hedysarum digging habitat used by grizzly bears in Banff National Park, Alberta: Summary of results from the 1995 field season. Banff National Park. Banff, AB. 13 pp.

Hamer, D., and S. Herrero. 1983. Ecological studies of the grizzly bear in Banff

National Park: final report. Parks Canada, Calgary, AB. 303 pp.

Hamer, D., S. Herrero, and K. Brady. 1985. Studies of the grizzly bear in Waterton Lakes National Park: final report. Parks Canada, Calgary, AB. 185 pp.

Hamer, D. and S. Herrero. 1987. Wildfire's influence on bear feeding ecology in Banff National Park, Alberta. Pp. 179-186 in Bears, their biology and management: a selection of papers from the 7th International Conference on Bear Research and Management (P. Zager, J. Beecham, G. Matula Jr., and H. Reynolds, eds.). International Association for Bear Research and Management, Williamsburg, VA.

Hamer, D. and S. Herrero. 1991. Elk, *Cervus elaphus*, calves as food for grizzly bears, *Ursus arctos*, in Banff National Park, AB. Can. Field.Nat. 105(1):101-103.

Hamer, D., S. Herrero, and K. Brady. 1991. Food and habitat used by grizzly bears, *Ursus arctos*, along the continental divide in Waterton Lakes National Park, Alberta. Can. Field.Nat. 105(3):325-329.

Harris, R. B. 1986. Modelling sustainable harvest rates for grizzly bears. Pp. 268-279 in Programmatic Environmental Impact Statement – The grizzly bear in Northwestern Montana. (A. Dood, R. Brannon, and R. D. Mace eds.). Montana Dept. Fish, Wildlife and Parks, Helena, MT.

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. 1999. Cumulative effects practitioner guide. Prepared by AXYS Environmental Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, QB.

Herrero, S. 1978. A comparison of some features of the evolution, ecology and behaviour of black and grizzly/brown bears. Carnivore 1(1):7-17.

Herrero, S. 1985. Bear attacks-their causes and avoidance. Winchester Press, Piscataway, NJ. 287 pp.

Herrero, S. 1992. The significance of the Wind Valley for mammalian carnivores. Canadian Parks and Wilderness Society, Calgary, AB. 23pp.

Herrero, S., and J. Herrero. 1996. Cheviot Mine Project: specific and cumulative environmental effects analysis for mammalian carnivores. Prepared by BIOS Env. Res. and Planning Assoc. Ltd. for Cardinal River Coals Ltd., Hinton, AB. 122 pp.

Herrero, S., P. S. Miller, and U. S. Seal (eds.). 2000. Population and habitat viability assessment for the grizzly bear of the Central Rockies Ecosystem (*Ursus arctos*). Eastern Slopes Grizzly Bear Project, University of Calgary, Calgary, Alberta, Canada and Conservation Breeding Specialist Group, Apple Valley, Minnesota, USA.

Herrero, S., D. Poll, M. Gibeau, J. Kansas, and B. Worbets. 1997. The Eastern Slopes Grizzly Bear Project: Origins, organization and direction. Proceedings of the Canadian Ecological Areas Council Conference, Calgary, AB, 1995.

Hewitt, D. G. 1989. Correcting grizzly fecal

analysis to observed food habits. Department of Natural Resource Sciences, Washington State University, Pullman, WS.

Holcroft, A. C. and S. Herrero. 1984. Grizzly bear digging sites for *Hedysarum sulphurescens* roots in southwestern Alberta. Canadian Journal of Zoology. 62 (12):2571-2575.

Holling, C. S. 1973. Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4:1-23.

Hovey, F. W. and B. N. McLellan. 1996. Estimating population growth of grizzly bears from the Flathead River drainage using computer simulation of reproductive and survival rates. Can. J. Zool. 74:1409-1416.

Idaho Conservation Data Centre. 2001. Species Lists. Natural Heritage Network. URL: http://www2.state.id.us/fishgame/info/cdc/cdc.htm [Accessed: 25 July 2001].

Jalkotzy M., I. Ross, and J. R. Gunson. 1992. Management plan for cougars in Alberta. Wildlife Management Planning Series No. 5. Alberta Forestry, Lands and Wildlife, Edmonton, AB. 91pp.

Jalkotzy, M. G., R. Riddell, and J. Wierzchowski. 1998. Grizzly bears and habitat effectiveness in the Skoki, Baker, South Pipestone, and Lake Louise Bear Management Units, Banff National Park. Draft report prepared for Banff National Park Warden Service, Banff, AB. 88 pp.

Jorgensen, C. J. 1983. Bear - sheep interactions. Pp. 191-200 in Bears, their biology and management: a selection of papers from the 5th International Conference on Bear Research and Management (E. C. Meslow, ed.). International Association for Bear Research and Management, Madison, WI.

Kansas, J. L. (in press). Effects of mapping scale, disturbance coefficients and seasonal habitat on grizzly bear habitat effectiveness modelling in Kananaskis Country, Alberta. M.Sc. thesis, University of Calgary, Calgary, AB.

Kansas, J.L. and D.M. Collister. 1999a. Specific and cumulative impact statement for mammalian carnivores: Gregg River Mine Extension. Prepared for Luscar Ltd. - Gregg River Mine, Hinton, by URSUS Ecosystem Management Ltd., Calgary, AB. 151 pp.

Kansas, J. L., and D. M. Collister. 1999b. Cumulative effects assessment for grizzly bears: supplemental information-Cheviot Mine Project. Prepared for Cardinal River Coals Ltd. by URSUS Ecosystem Management Ltd., Calgary, AB. 87 pp.

Kansas, J.L. and J. Herrero. 1999. Specific and cumulative impact statement for mammalian carnivores: South Block and West Extension. Prepared for Luscar Ltd. - Coal Valley Mine, Edson, by URSUS Ecosystem Management Ltd., Calgary, AB. 133 pp.

Kansas, J. L., and C. Newyar. 1998. Eastern Slopes Grizzly Bear Project – habitat mapping and evaluation component: progress report (1994 to 1997). Prepared for the Alberta Conservation Association and the Eastern Slopes Grizzly Bear Project Steering Committee. Edmonton, AB. 23 pp.

Kansas, J. L., and R. N. Riddell. 1995. Grizzly bear habitat model for the four contiguous mountain national parks: Second Iteration. Canadian Parks Service, Calgary, AB. 109 pp.

Kansas, J., R. Usher, and J. Bowen. 1997. Grizzly bear status and habitat effectiveness – Moose Mountain study area. Prepared by URSUS Ecosystem Management Ltd. and GAIA Consultants Inc. for Husky Oil. Calgary, AB. 56 pp.

Knight, R. R., B. M. Blanchard, and L. E. Eberhardt. 1988. Mortality patterns and population sinks for Yellowstone grizzly bears, 1973-85. Wildl. Soc. Bull. 16:121-125.

Knight, R. R., and L. L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. Ecology 66:323-334.

Knight, R. R., and S. L. Judd. 1983. Grizzly bears that kill livestock. Pp. 186-190 in Bears, their biology and management: a selection of papers from the 5th International Conference on Bear Research and Management (E. C. Meslow, ed.). International Association for Bear Research and Management, Madison, WI.

LeFranc, M. N., M. B. Moss, K. A. Patnode, and W. C. Sugg (eds.). 1987. Grizzly Bear Compendium. Interagency Grizzly Bear Committee and National Wildlife Federation, Washington, D.C.

Lovejoy, T. E., B. O. Bierregaard, Jr., K. S. Brown, L. H. Emmons, and M. E. Van der Voort. 1984. Ecosystem decay of Amazon forest fragments. Pp. 295-325 in Extinctions. (M. H. Niteki, ed.). University of Chicago Press, Chicago, IL.

Mace, R. D. and G. N. Bissell. 1985. Grizzly bear food resources in the floodplains and avalanche chutes of the Bob Marshall Wilderness, Montana. Pp. 78-91 in Proceedings of the Grizzly Bear Habitat Symposium (G. P. Contreras and K. E. Evans, compilers). U.S. For. Serv. Gen. Tech. Rept. INT-207, Ogden, UT.

Mace, R. D., and T. L. Manley. 1993. South Fork Flathead River Grizzly Bear Project: Progress report for 1992. Montana Department of Fish, Wildlife and Parks, Helena, MT. 34 pp.

Mace, R. D., J. S. Waller, T. L. Manley, L. J. Lyon, and H. Zuuring. 1996. Relationships among grizzly bears, roads, and habitat in the Swan Mountains, Montana. J. Appl. Ecol. 33:1395-1404.

Mace, R. D., and J. S. Waller. 1997. Final report: grizzly bear ecology in the Swan Mountains. Montana Fish, Wildlife and Parks, Helena, MT. 191 pp.

Manitoba Conservation Data Centre. 2001. Biodiversity Database. Manitoba Natural Resources. URL: http://www2.gov.mb.ca/natres/db/ [Accessed: 20 September 2001].

Martin, P. A. 1983. Factors influencing globe huckleberry fruit production in Western Montana. Pp. 159-165 in Bears, their biology and management: a selection of papers from the 5th International Conference on Bear Research and Management (E. C. Meslow, ed.). International Association for Bear Research and Management, Madison, WI.

Mattson, D. J. 1990. Human impacts on bear habitat use. Pp. 33-56 in Bears, their

biology and management: a selection of papers from the 8th International Conference on Bear Research and Management (L. M. Darling and W. R. Archibald, eds.). International Association for Bear Research and Management, Victoria, BC.

Mattson, D. J. 1993. Background and proposed standards for managing grizzly bear habitat security in the Yellowstone Ecosystem. Cooperative Park Studies Unit, University of Idaho, Moscow, ID. 17 pp.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1992. Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. J. Wildl. Manage. 56:432-442.

Mattson, D. J., S. Herrero, R. G. Wright, and C. M. Pease. 1996. Conserving Rocky Mountain Grizzly Bears: a model of science and management. Cons. Biol. 10:1013-1025.

Mattson, D. J., R. R. Knight, and B. M. Blanchard. 1987. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. Pp. 259-273 in Bears, their biology and management: a selection of papers from the 7th International Conference on Bear Research and Management (P. Zager, J. Beecham, G. Matula Jr., and H. Reynolds, eds.). International Association for Bear Research and Management, Williamsburg, VA.

Mattson, D. J. and R. R. Knight. 1991. Application of cumulative effects analysis to the Yellowstone grizzly bear population. Interagency Grizzly Bear Study Team Report 1991C. 8 pp.

McCrory, W., and S. Herrero. 1982. A review of the historical status of the grizzly bear in Kananaskis Country, Alberta. Prepared for Alberta Fish and Wildlife Division by BIOS Environmental Research and Planning Associates Ltd., Calgary, AB 123 pp.

McCrory, W., S. Herrero, and T. Toth. 1982. Grizzly bear habitat potential and feeding areas in the Kananaskis and Spray Lakes Valleys. Prepared for Alberta Fish and Wildlife Division by BIOS Environmental Research and Planning Associates Ltd,. Calgary, AB. 372 pp.

McLellan, B. N. 1989. Dynamics of a grizzly bear population during a period of industrial resource extraction. Density and age-sex composition. Can. J. Zool.67:1856-1860.

McLellan, B. N. 1992. Current status and long term threats to grizzly bears in British Columbia. Pp.111-122 in Community Action for Endangered Species (S. Rautio ed.). September 28-29,1991. Vancouver, B.C.

McLellan, B. N., F. W. Hovey, R. D. Mace, J.G. Woods, D. Carney, M. L. Gibeau, W. L. Wakkinen and W. F. Kasworm. 1999. Rates and causes of grizzly bear mortality in the interior mountains of British Columbia, Alberta, Montana, Washington and Idaho. J. Wildl. Manage. 63(3):911-920.

McLellan, B. N., and D. M. Shackleton. 1988. Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use, and demography. J. Appl. Ecol. 25:451-460.

Mealey, S. P. 1975. The natural food habits of free-ranging grizzly bears in Yellowstone National Park, 1973-1974. M.Sc. thesis, Montana State University, Bozeman, MT. 158pp.

Miller, S. D. 1990. Impact of increased bear hunting on survivorship of young bears. Wildl. Soc. Bull. 8:462-467.

Montana Natural Heritage Program. 2001. Species of Special Concern: Watch Lists. Natural Heritage Network. URL: http://nris.state.mt.us/mtnhp/ [Revision date: 1 July 2001].

Mowat, G., and J. Russell. 1998. Estimating Population Size of Grizzly Bears Using Hair Capture and DNA Fingerprinting in southwest Alberta. Report prepared for Alberta Environmental Protection, Natural Resources Service, Claresholm, AB, and Waterton Lakes National Park, Waterton Lakes, AB. 19 pp.

Nagy, J. A., A. W. L. Hawley, M. W. Barret and J. W. Nolan. 1989. Population characteristics of grizzly and black bears in west-central Alberta. Alberta Environment Centre, Vegreville, AB. 35 pp.

Nagy, J. A., and R. H. Russell. 1978. Ecological studies of the boreal forest grizzly bear (*Ursus arctos*) — annual report for 1977. Can. Wildl. Serv. Rept., Edmonton, AB. 104 pp.

Nagy, J. A., R. H. Russell, A. M. Pearson, M. C. Kingsley, and B. C. Goski. 1983a. Ecological studies of grizzly bears in the Arctic Mountains, northern Yukon Territory, 1972 to 1975. Can. Wildl. Serv. Rept. Edmonton, AB. 104 pp.

Nagy, J. A., R. H. Russell, A. M. Pearson, M. C. Kingsley, and C. B. Larsen. 1983b. A study of grizzly bears on the barren grounds of Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, 1974-1978. Can.Wildl. Serv. Rept., Edmonton, AB. 136pp.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, DC. 271 pp.

Natural Resources Conservation Board (NRCB). 1993a. Decision Report: application to construct a recreational tourist project in the town of Canmore, Alberta. Application 9103 – Three Sister's Resorts Inc., NRCB, Edmonton, AB.

Natural Resources Conservation Board (NRCB). 1993b. Decision Report. Vacation Alberta Corporation application to construct recreational and tourist facilities in the West Castle Valley, near Pincher Creek, Alberta. NRCB, Edmonton, AB.

NatureServe: An online encyclopedia of life [web application]. 2001. Version 1.4. Arlington, Virginia, USA: Association for Biodiversity Information. Available: http://www.natureserve.org/ [Accessed: 25 July 2001].

Nielsen, P. L. 1975. The past and present status of the plains and boreal forest grizzly bear in Alberta. Can. Wildl. Serv. Rept. Edmonton, AB. 61 pp.

Noble, L. B. 1972. Man and grizzly bear in Banff National Park, Alberta. M.A. thesis, University of Calgary, AB. 119 pp.

Northern East Slopes Environmental Resources Committee. 2000. Grizzly bear

conservation in the Alberta Yellowhead ecosystem: a strategic framework. Draft for consultation. 29 pp.

Pearson, A. M. 1975. The northern interior grizzly bear *Ursus arctos*. L. Can. Wildl. Serv. Rept. Ser. No. 34, Ottawa, ON. 86 pp.

Pedocan Land Evaluation Ltd. 1984. Preliminary wildlife habitat regions/subregions of Alberta – extended legend. Prepared for Alberta Energy and Natural Resources, Fish and Wildlife Division, Edmonton, AB. 44 pp.

Picton, H. D., D. M. Mattson, B. M. Blanchard, and R. R. Knight. 1986. Climate, carrying capacity, and the Yellowstone grizzly bear. Pp. 129-135 in Proceedings-Grizzly Bear Habitat Symposium (G. P. Contreras, and K. E. Evans, compilers). Intermountain Research Station Gen. Tech. Rept. INT-207, Ogden, UT. 252 pp.

Pritchard, H. D. and C. T. Robbins. 1990. Digestive and metabolic efficiencies of grizzly bears and black bears. Can. J. Zool. 68:1645-1651.

Raine, R. M., and R. N. Riddell. 1991. Grizzly bear research in Yoho and Kootenay National Parks. Canadian Parks Service Report, Calgary, AB.

Rogers, L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. Trans. N. Am. Wildl. Nat. Resour. Conf. 41:431-438.

Russell, R. H., J. W. Nolan, N. G. Woody, and G. H. Anderson. 1979. A study of the grizzly bear in Jasper National Park 1975 to 1978. Canadian Wildlife Service, Edmonton, AB. 102 pp. plus 10 appendicies.

Saunders, D. A., R. J. Hobbs, and C. R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. Conserv. Biol. 5:18-30.

Servheen, C. 1981. Grizzly bear ecology and management in the Mission Mountains, Montana. Ph.D. thesis, University of Montana, Missoula, MT. 139 pp.

Servheen, C. 1990. The status and conservation of the bears of the world. Int. Conf. Bear Res. and Manage. Monograph Series No.2. 32pp.

Sherry, E. E. 1996. An analysis of methodologies used for assessing grizzly bear (*Ursus arctos horribilis*) population. M.Sc. thesis, University of Kent, Canterbury, UK. 155 pp.

Sizemore, D. L. 1980. Foraging strategies of the grizzly bear as related to its ecological energetics. M.Sc. thesis, University of Montana, Missoula, MT. 67pp.

Sonntag, N. C., R. R. Everitt, L. P. Rattie, D. L. Colnett, C. P. Wolf, J. C. Truett, A. H. J. Dorcey, and C. S. Holling. 1987. Cumulative effects assessment: A context for further research and development. A background paper prepared for the Canadian Environmental Assessment Research Council. Minister of Supply and Services Canada, Hull, QC. 91 pp.

Spry, I. M. 1968. The papers of the Palliser Expedition 1857-1860. The Champlain Society, Toronto, ON.

Stelmock, J. J. 1981. Seasonal activities and habitat use patterns of brown bears in Denali National Park-1980. M.Sc. thesis, University of Alaska, Fairbanks, AK. 118 pp.

Stenhouse, G.B. 2000. Foothills Model Forest Grizzly Bear Research Program 1999 Annual Report. Foothills Model Forest, Box 6330, Hinton, AB. 134 pp.

Stenhouse, G. and R. Munro. 2001. Foothills Model Forest Grizzly Bear Research Program 2000 Annual Report. Foothills Model Forest, Box 6330, Hinton, AB. 87 pp.

Storer, T. I., and L. P. Tevis Jr. 1955. California Grizzly. University of California Press, Berkeley, CA. 335pp.

Stringham, S. F. 1980. Possible impacts of hunting on the grizzly/brown bear, a threatened species. Pp. 337-349 in Bears, their biology and management: a selection of papers from the 4th International Conference on Bear Research and Management (C. J. Martinka, and K. L. McArthur, eds.). International Association for Bear Research and Management, Kalispell, MT.

Stringham, S. F. 1983. Roles of adult males in grizzly bear population biology. Pp. 140-151 in Bears, their biology and management: a selection of papers from the 5th International Conference on Bear Research and Management (E. C. Meslow, ed.). International Association for Bear Research and Management, Madison, WI.

USDA Forest Service. 1990. CEM-A model for assessing effects on grizzly bears. United States Department of Agriculture - Forest Service, Missoula, MT. 24pp.

US Fish and Wildlife Service. 2001. Species Information: Threatened and Endangered Animals and Plants. Washington D.C. 20240. URL: http://endangered.fws.gov/ [Revision date: 9 July 2001].

Vroom, G. W., S. Herrero, and R. T. Ogilvie. 1980. The ecology of winter den sites in Banff National Park, Alberta. Pp. 321-330 in Bears, their biology and management: a selection of papers from the 4th International Conference on Bear Research and Management (C. J. Martinka and K. L. McArthur, eds.). International Association for Bear Research and Management, Kalispell, MT.

Waller, J. S. 1992. Grizzly bear use of habitats modified by timber harvest. M.Sc. thesis, Montana State University, Bozeman, MT. 64pp.

Washington Natural Heritage Program. 2001. Reference Desk. State of Washington, Department of Natural Resources. URL: http://www.wa.gov/dnr/htdocs/fr/nhp/wanhp.html [Revision date: September 2000].

Weaver, J., R. Escano, D. Mattson, T. Puchlerz, and D. Despain. 1986. A cumulative effects model for grizzly bear management in the Yellowstone Ecosystem. Pp. 234-236 in Proceedings-Grizzly bear Habitat Symposium (G. P. Contreras, and K. E. Evans, compilers). Intermountain Research Station Gen. Tech. Rept. INT-207. Ogden, UT. 252 pp.

Weaver, J. L., P. C. Paquet, and L. F. Ruggerio. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. Conserv. Biol. 10:964-976.

Wielgus, R. B. 1986. Habitat ecology of the grizzly bear in the southern Rocky Mountains of Canada. M.Sc. thesis, University of Idaho, Moscow, ID. 136 pp.

Wielgus, R. B., and F. L. Bunnel. 1994. Dynamics of a small hunted brown bear population in southwestern Alberta, Canada. Biol. Cons. 67:161-166.

Wyoming Natural Diversity Database. 2001. Species of Special Concern. University of Wyoming, Laramie, WY. URL: http://uwadmnweb.uwyo.edu/wyndd/ [Revision date: 3 May 2001].

Young, F. M. and C. Beyers. 1980. Man Meets Grizzly. Houghton-Mifflin Co., Boston, MA. 298 pp.

Zager, P. 1980. The influence of logging and wildfire on grizzly bear habitat in northwestern Montana. Ph.D. dissertation, University of Montana, Missoula, MT. 131 pp.

Zager, P., C. Jonkel, and J. Habeck. 1983. Logging and wildfire influence on grizzly bear habitat in northwestern Montana. Pp. 124-132 in Bears, their biology and management: a selection of papers from the 5th International Conference on Bear Research and Management (E. C. Meslow, ed.). International Association for Bear Research and Management, Madison, WI.

APPENDIX 1. Definitions of selected legal and protective designations.

A. The General Status of Alberta Wild Species 2000 (after Alberta Sustainable Resource Development 2001)

2000 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be at risk after formal assessment and designation as Endangered in Alberta or in Canada (in the part of the range that includes Alberta).
May Be At Risk	Blue	Any species believed to be at risk. These species will require a detailed assessment for possible formal designation as Endangered or Vulnerable.
Sensitive	Yellow	Any species known to be, or believed to be, particularly sensitive to human activities or natural events.
Secure	Green	Any species known to be, or believed to be, not at risk.
Undetermined	Status Undetermined	Any species where not enough information exists to adequately use the ranking system (exceptional cases only).
Not Assessed	n/a	Any species known or believed to be present but which have not yet been evaluated.
Exotic/Alien	n/a	Any species that have been introduced as a result of human activity.
Extirpated/Extinct	n/a	Any species no longer thought to be present in the jurisdiction or are believed to be extinct.
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably outside their usual range.

B. Alberta Wildlife Act

Species designated as 'endangered' under the Alberta Wildlife Act include those defined as 'endangered' or 'threatened' by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade.
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed.

C. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

D. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2001)

Extinct	A wildlife species that no longer exists.
Extirpated	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
Endangered	A wildlife species that is facing imminent extirpation or extinction.
Threatened	A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern (Vulnerable)	A wildlife species of special concern because it is particularly sensitive to human activities or natural events, but does not include an extirpated, endangered or threatened species.
Not at Risk	A wildlife species that has been evaluated and found to be not at risk.
Indeterminate	A species for which there is insufficient scientific information to support status designations.

E. Heritage Status Ranks: Global (G), National (N), Sub-National (S) (after NatureServe 2001)

G1/N1/ S1	**Critically Imperiled**: Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or linear miles (<10).
G2/N2/ S2	**Imperiled**: Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1000 to 3000) or acres (2000 to 10 000) or linear miles (10 to 50).
G3/N3/ S3	**Vulnerable**: Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3000 and 10 000 individuals.
G4/N4/ S4	**Apparently Secure**: Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences and more than 10 000 individuals.
G5/N5/ S5	**Secure**: Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10 000 individuals.
GX/NX/ SX	**Presumed Extirpated**—Element is believed to be extirpated from the nation or subnation*. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH/NH/ SH	**Possibly Extirpated** (Historical)—Element occurred historically in the nation or subnation*, and there is some expectation that it may be rediscovered. Its presence may not have been verified in the past 20 years. An element would become NH or SH without such a 20-year delay if the only known occurrences in a nation or subnation were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, NH or SH-ranked elements would typically receive an N1 or S1 rank. The NH or SH rank should be reserved for elements for which some effort has been made to relocate occurrences, rather than simply using this rank for all elements not known from verified extant occurrences.

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